BULLETIN

OF THE TEXAS MEMORIAL MUSEUM

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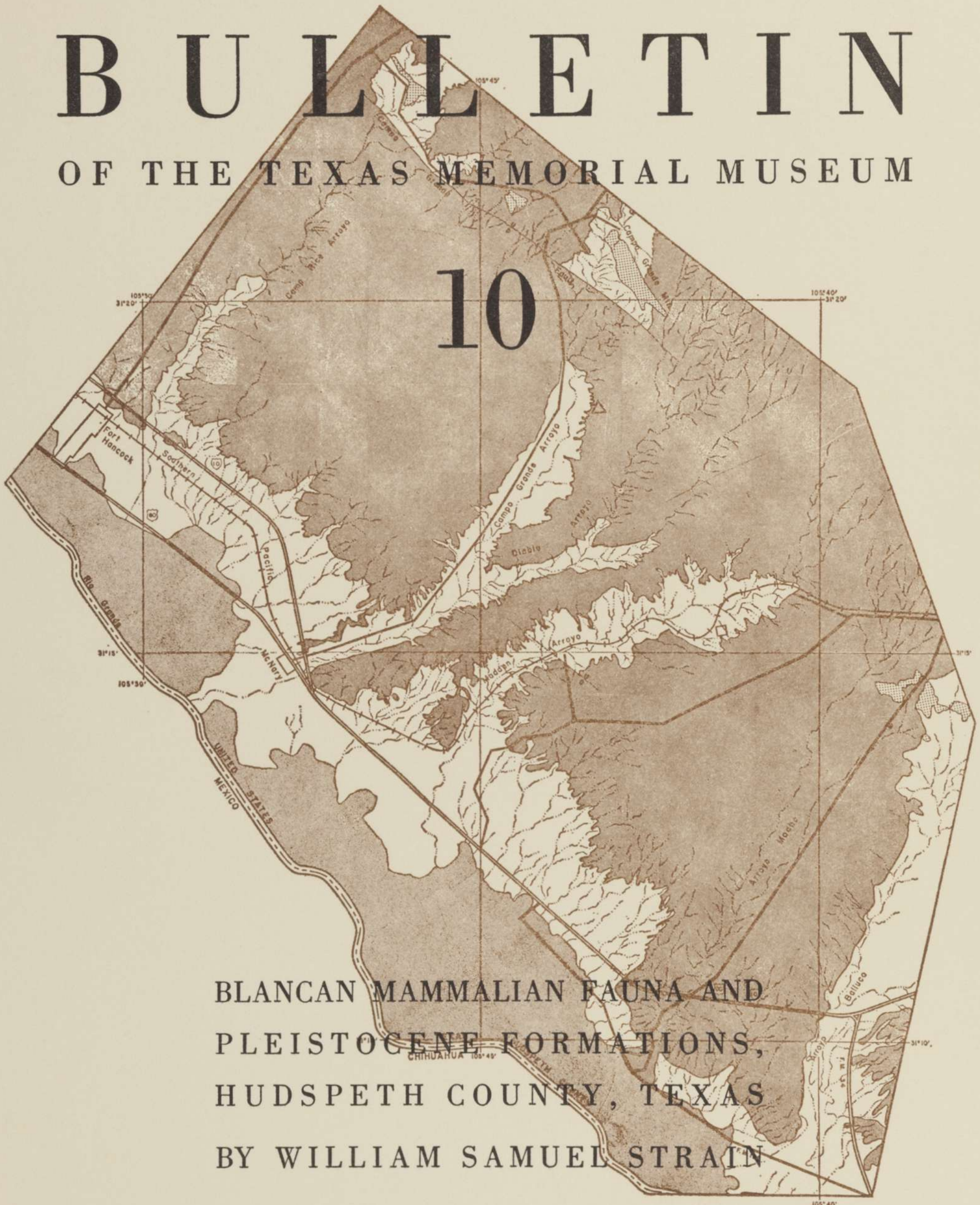

BLANCAN MAMMALIAN FAUNA AND
PLEISTOCENE FORMATIONS,
HUDSPETH COUNTY, TEXAS

BY WILLIAM SAMUEL STRAIN

Texas Memorial Museum / W. W. Newcomb, Director
24th and Trinity, Austin, Texas / The University of Texas

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Blancan Mammalian Fauna and Pleistocene Formations Hudspeth County, Texas

WILLIAM S. STRAIN*

Abstract: Vertebrate fossils representing a new Blancan local fauna occur in the Fort Hancock Formation (new name) and the Camp Rice Formation (new name), Hueco Bolson (Fig. 1) Hudspeth County, Texas. Fossils indicate the Fort Hancock Formation and the lower part of the Camp Rice Formation are probably Aftonian in age. Pearlette volcanic ash dates the middle of the Camp Rice as late Kansan. It also provides a precise horizon for correlating the Pleistocene stratigraphic section of the Great Plains with that in the Hueco Bolson.

The Fort Hancock Formation is composed of clay, silt, fine sand, and gypsum. Silt, sand, gravel, some clay, and volcanic ash characterize the Camp Rice Formation. An unconformity separates the formations. The Fort Hancock was deposited in a closed basin, but the Camp Rice represents fluvial and floodplain deposition by the Rio Grande after it developed as a through-flowing stream in the Hueco Bolson during late Kansan.

Introduction

For many years uncertainty has existed concerning the precise age of the late Cenozoic rocks exposed in the Rio Grande Valley in Hudspeth County, Texas. The uncertainty resulted from a lack of fossils that could be correlated with known faunas elsewhere. Gravel pits in young basin fill have yielded mammoth and *Equus* remains, but fossils from the older strata of the fill were almost unknown. Richardson (1909: 5) reported tapir and other Pleistocene vertebrate remains from El Paso, but these were not from the older rocks. Bryan (1938: 205) considered the age of the Rio Grande fill to be Pliocene. Sayre and Livingston (1945: 39) cited his conclusion in support of their age assignment of the oldest exposed strata. Albritton (1938) and Smith and Albritton (oral communication, 1956) searched the immediate area of this investigation, but found no fossil material adequate to date the Cenozoic strata.

I undertook the research here reported hoping to find paleontologic evidence to establish, with a greater degree of certainty, the age of the strata and the geologic history of the region. In an area in Hudspeth County, Texas, near the towns of Fort Hancock and McNary, the strata are well exposed. The Rio Grande traverses the Hueco Bolson from El Paso to the Quitman Mountains, and the principal exposures of Cenozoic rocks are along its intermittent tributary streams.

The area of intense investigation is in the southwestern part of the bolson. It is bounded on the north by the Finlay Mountains and the Diablo Plateau, on the east by the Quitman Mountains, and on the south by the Rio Grande. On the west its approximate boundary is the El Paso-Hudspeth County line (Fig. 2). The area is bounded by lat. 31°10′ N., lat. 31°20′ N.; long. 105°32′ W., and long. 105°55′ W.

Fossils are exceedingly rare in these strata. I spent most of the summer months of 1956, 1957, and 1958 in a careful search for the materials here described.

Acknowledgments

I am greatly indebted to many individuals for assistance during the progress of this research and to those whose names are not mentioned, I express my sincere appreciation. Thanks are especially due to Mr. and Mrs. Percy W. McGhee for their interest and support. To Mr. and Mrs. John

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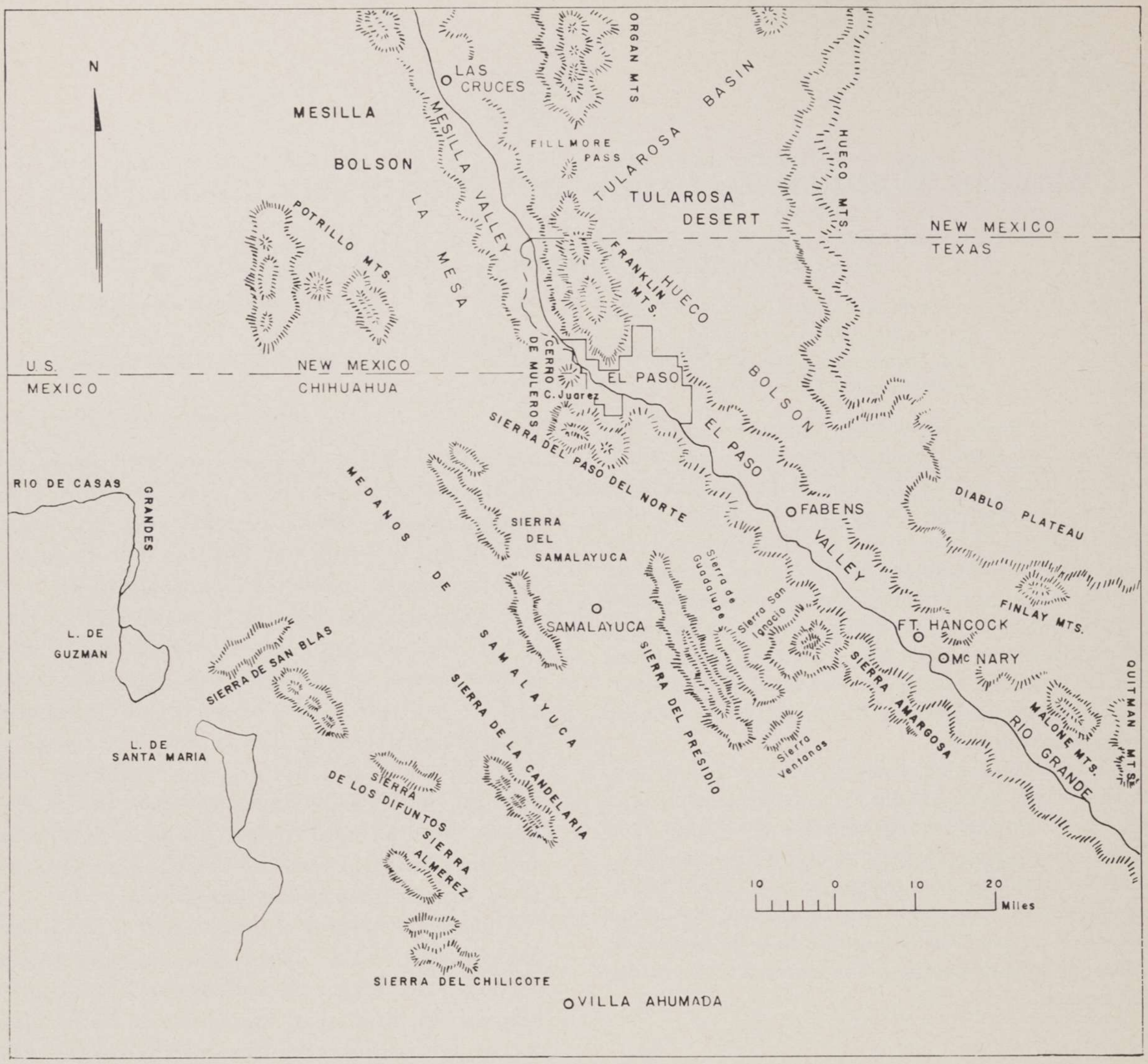

Fig. 1. Physiographic sketch map of Hueco Bolson area.

E. Kimmel, Mrs. Edward Kimmel, and the late Colonel Edward Kimmel, the writer acknowledges innumerable kindnesses shown him. The field work was made more pleasant by the many courtesies extended by Mr. and Mrs. Tommy Powell and Mr. and Mrs. Travis Irby of McNary, Texas. Mr. Monroe Walbridge, Mr. James Bowden, Mr. Frank Owen, and Mr. Lenox W. Moore kindly permitted me to enter their properties and collect fossils on their lands. Dr. Ada Swineford, State Geological Survey of Kansas, and Dr. Howard A. Powers, United States Geological Survey, were kind enough to identify samples of Pearlette Ash.

I wish to express my appreciation to the following for the loan of both fossil and recent mammal materials for comparative study: Dr. Claude W. Hibbard, Museum of Paleontology, University of Michigan; Dr. Robert W. Wilson and Dr. E. Raymond Hall, Museum of Natural History, University of Kansas; Dr. J. E. Wood, New Mexico State University; Dr. W. Frank Blair, The University of Texas; Dr. Gerald G. Raun, Texas Memorial Museum; Dr. W. B. Davis, Agricultural and Mechanical College of Texas; Mr. Jack Hughes, Panhandle Plains Historical Society Museum.

My deep gratitude is expressed to the Southern Fellowships Fund, the Ohio Oil Company, the

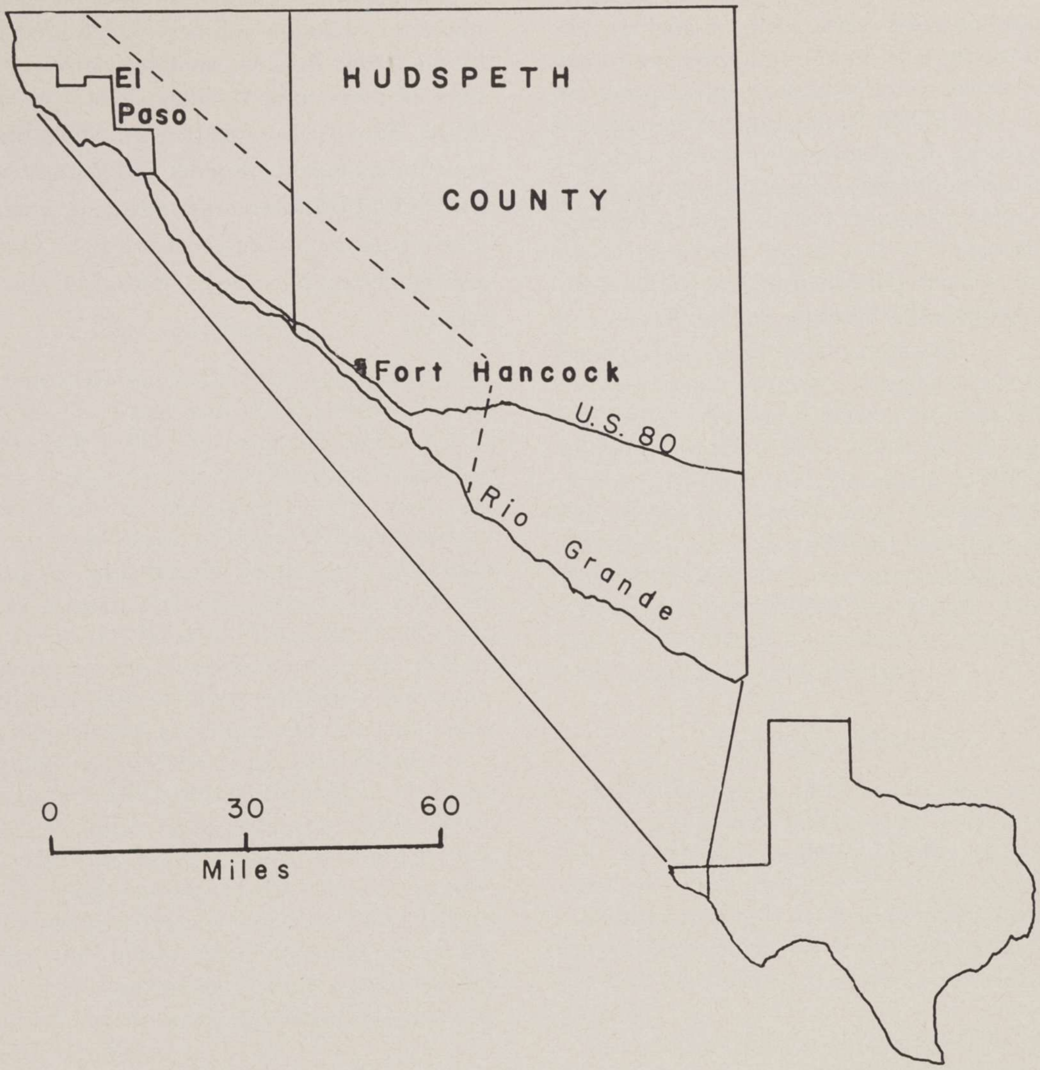

Fig. 2. Area of investigation outlined by dashed line.

Humble Oil and Refining Company, and the Texas Western College Research Committee for their support.

Sincere thanks are expressed to Dr. John A. Wilson for invaluable advice and for offering many helpful suggestions, and to Dr. William R. Muehlberger, Dr. Claude W. Hibbard, Dr. W. Frank Blair, Professor Ronald K. DeFord, and Dr. Ernest L. Lundelius, Jr. who have assisted the writer by giving freely of their time in discussing various aspects of the problem.

Appreciation is expressed to Mr. Donald Crouch who drew the illustrations and who worked untiringly during their preparation.

Materials and Methods

Mapping. The Fort Hancock, Finlay Mountains, McNary, and Fort Quitman quadrangles prepared by the United States Geological Survey (scale 1:62,500) were used to determine geographic location, elevation, and topographic fea-

tures. Aerial mosaics (scale 1:62,500) aided in understanding gross relationships of geologic features. Mapping was done by plotting the formation boundaries on aerial photographs reproduced to a scale of 1:15,840. Photographs were adjusted to compensate for distortion; cultural and geologic features outlined on them were traced.

Rock-color Standard. Colors used to describe rocks discussed in this paper are those in the Rock-Color Chart published by the National Research Council, Washington, D.C., 1948.

Abbreviations. Fossils are designated by their museum catalogue numbers which are preceded by the letters B. E. G., an abbreviation of the Bureau of Economic Geology, The University of Texas. The first five numbers following the letters constitute a locality number and the number after the dash identifies the individual specimen. If no letters precede a number, it is a B. E. G. number and the letters have been omitted for the sake of brevity.

Geology of the Hueco Bolson

Physical Setting

The Hueco Bolson lies near the southeastern extremity of the Basin and Range Physiographic Province. Hill (1900: 8) originally defined it as the area lying between the Franklin-Organ-San Andreas chain of mountains on the west and the Sacramento–Hueco–Finlay–Malone–Quitman chain on the east. On the southwest a mountain chain in Mexico including Sierra del Paso del Norte, Sierra del Presidio, Sierra de Guadalupe, and Sierra de San Ignacio borders the bolson. Richardson (1909: 2) observed that a low transverse ridge divides the basin into two sub-basins a few miles north of the Texas-New Mexico state boundary. The area north of this ridge is the Tularosa Desert, which has no drainage outlet. South of the ridge the Hueco Bolson is drained only along the southwestern margin where it is traversed by the Rio Grande. From the New Mexico state line the bolson extends southward to the latitude of El Paso where it turns southeastward to terminate south of the Quitman Mountains in Hudspeth County.

In Hudspeth County and the adjoining sections of El Paso County, the Rio Grande crosses the southern and southwestern parts of the bolson. The river enters the bolson at El Paso through the narrows between Cerro de Muleros and the Franklin Mountains called El Paso Canyon. The river exits through a canyon south of the Quitman Mountains. The Rio Grande depression near El Paso is called the El Paso Valley (Fig. 1).

The El Paso Valley has a maximum width of about 8 miles and varies in depth from about 200 feet at El Paso to approximately 250 feet near McNary. The floodplain is 4 to 5 miles wide and the sides of the valley rise rather steeply to the Mesa Rim or general level of the bolson surface. The Mesa Rim is generally an abrupt escarpment, which may be 75 to 80 feet high. Along the Mesa Rim a resistant layer of caliche 4 or 5 feet thick, just below drifting sand, is normally responsible for the abruptness of the valley wall.

The Hueco Bolson is a structural trough where wells reveal the basin fill is more than 4,910 feet thick (King, 1935: 253). It has an average width of about 25 miles and the region southeast of El Paso is almost 80 miles long. The average elevation of its surface is 4,000 feet above sea level and the highest peaks of the surrounding mountains rise approximately 3,000 feet higher. The mountains are bordered by pediments, which may extend several miles into the basin.

Cenozoic History

At the beginning of Cenozoic time northwest-trending folds and faults created a series of ranges and troughs in northern Mexico and adjacent parts of Texas (King, 1935: 248). Early in the Cenozoic, probably prior to the Oligocene, Jurassic and Cretaceous strata were thrust several miles north or northeastward in south-central Hudspeth County.

Early in the Miocene Epoch block faulting and igneous intrusions formed mountains and basins in the same structural framework that exists today. Streams eroded the highlands and deposited their loads in the surrounding subsiding basins. According to Bryan (1938: 204) basins along the Rio Grande trench in New Mexico began to fill, as early as Miocene, with terrigenous particles washed from the surrounding highlands. Lakes developed in the individual depressions and eventually overflowed into adjoining ones, creating a stream which flowed through a series of lakes. The ancient stream thus formed was the initial Rio Grande. Neither the Hueco Bolson nor the Mesilla Bolson, west of the Franklin and the Organ Mountains, possessed a through-flowing stream at that time.

Lee (1907: 21), Bryan (1938: 198), and Kottlowski (1958: 46) believed that the initial Rio

Grande was not connnected with the Hueco Bolson, but terminated in a series of lakes in the vicinity of Laguna Guzman and Laguna de Santa Maria in northern Chihuahua. Ruhe (1962: 160–161) did not recognize evidence for such a stream and suggested that the gravel in the deposits is not stream-channel gravel, but is a part of a "widespread basinal fill with spill over low divides into adjacent basins." During the Pliocene the Mesilla Bolson and the Hueco Bolson continued to subside and to fill independently. By the end of the epoch the mountains were reduced to hills of low relief and were partly buried in their own debris. Prominent alluvial fans surrounded the mountains and extended into the basins. By selective transport, the coarsest materials remained near the mountains, and rock particles became finer toward the centers of the depressions so that only clay and silt-size particles reached the axes of the troughs. Early in the Pleistocene faulting recurred along old lines of weakness and the mountains again rose above the surrounding basins.

At times of moderately heavy precipitation the depressions contained one or more ephemeral lakes in which fine sediment settled, but during maximum flooding the basins overflowed to form a vast integrated network of confluent waters. I propose the lake thus formed be called Lake Cabeza de Vaca in honor of the first white man to enter its basin. This name was suggested to me by Dr. Charles Laurence Baker (written communication, 1951) who many years ago recognized evidence for the lake. Huge quantities of clay and silt, which originated to the north in New Mexico and Colorado, settled in the lakes to form well-bedded deposits which abutted against the surrounding mountains (Fig. 3). In spite of the tremendous volumes of water involved, gravel could only spread into the lakes for short distances around their peripheries. Even though at peak stages the lakes were widespread, their levels fluctuated so much that I have observed no wave-cut cliffs or benches.

During periods of slight rainfall chemical pre-

Fig. 3. Looking east at contact of Fort Hancock Formation with Cretaceous limestone, southeast side Campo Grande Mountain, Campo Grande Arroyo. View illustrates how Pleistocene lacustrine deposits abut against and cover older rocks in the Hueco Bolson. Fort Hancock Formation about eight feet thick at right side of view.

cipitates and evaporites accumulated and the lacustrine deposits often lay exposed to the atmosphere as indicated by the old soils, cut-and-fill features in the rocks, and the oxidation of the iron minerals. In these arid cycles, alluvial fans projected coarser material farther into the basins than on occasions when the intermittent lake levels were exceptionally high. During the aggrading process coarse detrital lenses became intercalated with the finer clastic particles around the margins of the bolsons.

I believe that the Mesilla and Hueco bolsons filled as essentially separate basins until the level of the floors of the basins reached the lowest pass between the Franklin and Organ mountains. This occurred at an elevation of about 3,700 feet as indicated by the logs of two wells drilled in Fillmore Pass (Knowles and Kennedy, 1956: 78–80). Subsequently, both bolsons continued to aggrade with a common level. The aggrading continued until the basin surfaces reached an elevation of approximately 4,200 feet. At that stage the Hueco-Mesilla surface was continuous with the level of bolsons in adjacent Mexico and for a time in early and middle Pleistocene the mountains stood surrounded by a wide aggradational plain occupying thousands of square miles in New Mexico, Texas, and northern Mexico.

In early Kansan time, ponded waters in the Hueco Bolson overflowed and formed an outlet to the southeast. The cutting of this spillway provided a channel for a stream to drain the basin.

During a period of low rainfall in early Kansan, the Rio Grande, then flowing in the Mesilla Bolson, altered its course to flow through Fillmore Pass between the Organ and the Franklin mountains and into the Hueco Bolson. The river then flowed southward parallel with the eastern side of the Franklins to near their south end where it turned southeast along the axis of the bolson. Andesite and rhyolite pebbles from the southwest part of the Organ Mountains (Dunham, 1935: 54–60) were spread many miles downstream by the river and identify its channel. The diversion of the river most likely resulted from headward erosion of an intermittent stream in the Hueco Bolson or from meandering of the Rio Grande in the Mesilla Bolson. With an increased volume of water, the river established a connection with a stream to the southeast which was working headward from the Gulf of Mexico and in late Kansan, the Rio Grande established essentially its present course.

Early Pleistocene faulting (Richardson, 1909: 9; King, 1935: 253–254; and Sayre and Livingston, 1945: 36) on the east side of the Franklin Mountains and along the northeastern margin of the mountain ranges in Mexico tilted the floor of the bolson westward and steepened the gradient of the stream in the basin. The fault had a maximum throw of about 350 feet (Sayre and Livingston, 1945: 36) with greater displacement at the south end than at the north and formed an east-facing escarpment between the Franklin Mountains and the Sierra del Paso del Norte.

An intermittent tributary of the stream in the Hueco Bolson quickly cut through the escarpment and into the Mesilla Bolson where it intersected the main stream near the southwest margin of the Organ Mountains and diverted its waters southward through El Paso Canyon into the Hueco Bolson. The diversion of the river probably took place late in Kansan time. Richardson (1909: 6) reported *Mammuthus columbi, Equus complicatus,* and *Tapirus haysii*? in north El Paso in gravel deposited by the Rio Grande after the river cut through El Paso Canyon. The association of mammoth and *E. complicatus* indicates a probable late Kansan age for the gravel (Hibbard, 1958: 6), and leads to the conclusion that the Rio Grande has cut the El Paso Valley and entrenched itself in the older basin fill since late Kansan. The fact that fossils younger than late Kansan have not been found in the highest terrace of the valley wall supports this conclusion.

This interpretation of the history of the Rio Grande in the Hueco Bolson differs from those of Bryan (1938: 198), Kottlowski (1958: 46), Sayre and Livingston (1945), and Ruhe (1962). The major departures from previously proposed theories are (1) that the Rio Grande flowed through Fillmore Pass and (2) the sequence of events related to the diversion of the river through El Paso Canyon.

General Character of Cenozoic Deposits

The oldest Cenozoic rocks visible in the Hueco Bolson are exposures of the Fort Hancock Formation along the margins of the El Paso Valley. They are evenly bedded red, brown, and gray clay-

stone, silty clay, and siltstone. The strata contain varying amounts of gypsum and bentonite. The rocks are characteristic of deposits in intermittent lakes and demonstrate there was no through-flowing stream in the basin at the time of deposition. King (1935: 256) and Sayre and Livingston (1945: 41) recognized that the rocks indicated deposition in temporary lakes. No wave-cut benches or cliffs are present to prove lake levels remained static for long periods of time. Soils formed under sub-aerial conditions and thin beds of gypsum and current-scour features formed in shallow water. In addition, there are no stream-channel deposits to indicate an established drainage pattern.

Cross-bedded silt lenses in some localities interrupt the even bedding and represent ephemeral streams or lake currents with low velocity which cut and filled channels contemporaneously with deposition. The general character of the bedding of the Fort Hancock Formation (new name) probably indicates lacustrine deposits periodically exposed to the atmosphere during periods of aridity. At the onset of periods of flooding, the first surges of water across the nearly level lake floor, or possibly currents in the shallow water as the basin filled, cut channels in the unconsolidated deposits and filled the trenches with silt.

The deposits (Fig. 4) are typical of basins with no surface outflow, which according to Wright (1946: 400) are characterized by a peripheral zone of alluvial fan material, and a central area composed of playa or lake deposits typified by clay, silt, fine sand, gypsum, various chemical precipitates, and evaporites.

The Camp Rice Formation, a sequence of channel gravel, sand, sandy and silty clay, and volcanic ash, capped in most places by caliche and drifting sand, rests upon the strata just described and is separated from them by an unconformity. The lower part of the Camp Rice consists of well-rounded river pebbles and fine to coarse sand. The pebbles originated in various areas on the borders of the basin, but came principally from

Fig. 4. Looking south at silt-filled channel in Fort Hancock Formation at type locality on east side of Madden Arroyo. Channel thickness about ten feet.

the Organ and Franklin mountains. Most of the pebbles are andesite or rhyolite, but some are granite, quartz, or chert.

Near the mountains alluvial-fan deposits consist of fragments of local rocks, poorly to moderately rounded and poorly sorted.

Wright (1946: 399) stated that basins traversed by a stream of major size will have two types of deposits:

(a) alluvial fan deposits consisting of gravel near the mountains and grading into sand, silt, and even clay toward the axis of the basin, and (b) river gravel distributed along the axis of the basin, with some fine sand, silt, and clay.

The channel gravel and the alluvial fan deposits of the Camp Rice are typical of the deposits in basins with through-flowing streams as described by Wright.

The change in type of sedimentary rocks in the bolson from that of a closed basin in the lower strata (Fort Hancock Formation) to rocks typical of a basin with a thorough-flowing stream (Camp Rice Formation) certainly reflects a change in the environment of deposition. This alteration took place when the Rio Grande was deflected from the Mesilla Bolson into the Hueco Bolson so as to establish a through-flowing stream in both.

Surface of the Bolson Fill

The surface of the basin fill is complex. In places it is a pediment and in places it is an alluvial-fan surface where these geomorphic features extend into the basin. The alluvial fans are generally covered with angular to rounded gravel which originated upslope in the drainage area. The pediments are usually covered with a thin veneer of gravel and wind-blown sand. Sand dunes and small hummocks of sand which accumulate around desert vegetation cover the central part of the basin. In the area of the El Paso Valley the profile of the surface reveals three terraces and an integrated sequence of geomorphic surfaces related to various stillstands in the erosional history of the Rio Grande since late Kansan.

Origin of the Bolson Deposits

Meinzer and Hare (1915: 66) stated that the deposits of the Tularosa Basin were derived from rocks of the surrounding mountains. Probably most of the basin fill of the Hueco Bolson originated in a similar way by weathering of rocks in the bordering mountains.

Gypsum and other salts came from Permian strata on the eastern flank of the bolson. Clay formed from the weathering of feldspathic minerals in the igneous rocks and from the decay of limestone and dolomite in the adjacent mountains. Minor amounts of clay also came from the destruction of shale lenses in contiguous areas.

Volcanic-ash falls, both of Pleistocene (Pearlette) and earlier Cenozoic origin, gave rise to the bentonitic constituents of clay. Weathering of granite, rhyolite, obsidian, and other igneous rocks supplied many of the silt and sand-size terrigenous particles. A considerable volume of silt and sand originated from the weathering of chert in the limestone and from the destruction of sandstone exposed in the adjoining mountains. The gravel contains pebbles of most of the rock types which outcrop along the periphery of the bolson. Near the mountains limestone pebbles compose the bulk of the alluvial fans, but diminish rapidly in amount as the fans extend into the basin. Pebbles of andesite and rhyolite (Soledad; Dunham, 1935: 56) form the mass of the channel gravel in the basin and are found many miles from their source. These pebbles, some of which originated on the southwest flank of the Organ Mountains, show that the earlier Rio Grande flowed through Fillmore Pass into the Hueco Bolson.

Structural Deformation

At the beginning of Cenozoic time broad arches and depressions characterized the Hueco Bolson area which was moderately elevated above sea level. Richardson (1909: 9), Bryan (1938: 204), and King (1935: 244) agreed that faulting deformed the region in Miocene time. Bryan (1938: 204) believed that the faulting that created the bolson and the surrounding mountains began in the Miocene.

The bolson is a graben about 100 miles long and 25 miles wide. Normal faults bound it on the east, west, and south. A combination of faulting and structural deformation of Lower Cretaceous rocks in the southern end of the Quitman Mountains originally closed the southeastern margin of the basin.

North of El Paso, near the Texas-New Mexico state line, the Burns and King oil-test well no. 4 penetrated the bolson fill to a depth of 4,910 feet

without encountering consolidated rock. At Fort Hancock a well drilled to a depth of 3,500 feet did not find the lower limit of the unconsolidated deposits (oral communication, A. J. Wafer, 1958). The faults bordering the western side of the bolson have throws aggregating several thousands of feet. On the eastern side of the bolson the Hueco Mountains dip toward the basin and are cut locally by normal faults with the down-thrown side toward the bolson. At the base of the range on the east side of the Franklin Mountains several fault scarps are visible and there has been at least 350 feet of vertical movement along them. Pleistocene and Recent movement on the faults caused the floor of the basin to slope westward about 17 feet per mile (Sayre and Livingston, 1945: 36). Elsewhere in the basin, normal faults have displaced strata of Pleistocene and Recent age. In the City of El Paso there are faults south and east of El Paso High School. Sayre and Livingston (1945, pl. 10, Fig. A) figured a tilted fault block near the intersection of Arizona and Alabama streets.

Along the south side of Campo Grande Mountain in Hudspeth County a fault with northwest strike displaces the Recent caliche as well as the underlying Pleistocene strata (Pl. I). Numerous small faults in the bolson have throws of 30 feet or less. These are mostly out in the basin and may be related to compaction of the bolson fill rather than to the major structural trends of the region.

After the Miocene-Pliocene faulting, during a period of quiescence, the mountains were reduced to low hills. Active faulting again took place in the Pleistocene and has continued into Recent time.

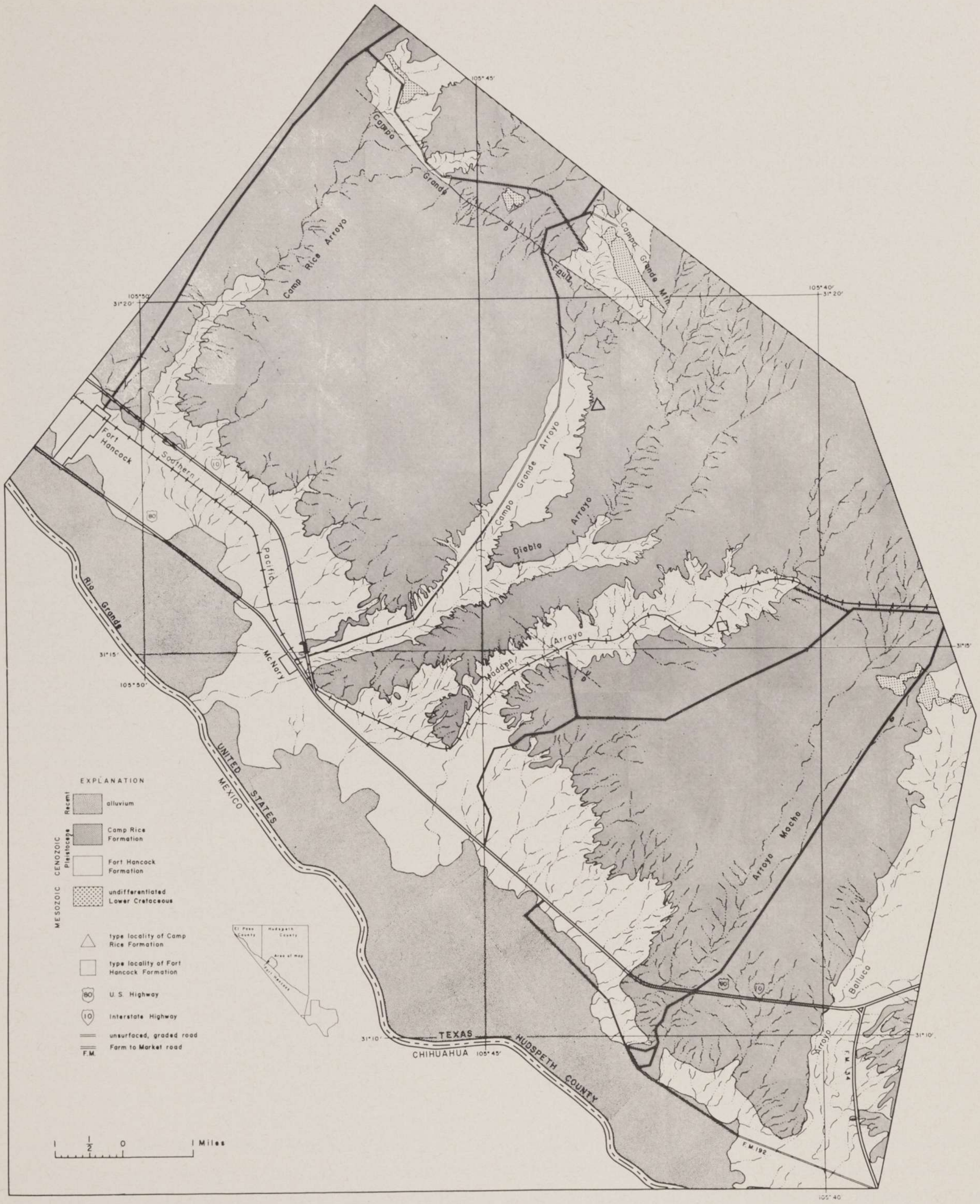

PLATE I

Geologic map of area in Hudspeth County, Texas

Fort Hancock and Camp Rice Formations

Discussion

Baker (1927: 39) directed attention to the lack of precise knowledge concerning the Cenozoic sedimentary rocks of Trans-Pecos Texas and implied that they might be, in part, equivalent to strata near Santa Fe, New Mexico which Hayden (1873) called "Santa Fe marls." The rocks are basin fill of the Rio Grande trench from which Cope, according to Baker (1927: 39), identified mammalian fossils of Miocene age. More recently, Bryan (1938: 205) and Denny (1940a: 84 and 1940b: 680) used the name "Santa Fe Formation" for the strata to which Hayden referred. Kottlowski (1958: 52) employed the term "Santa Fe Group" for similar rocks of Cenozoic age in the Rio Grande Valley in southern New Mexico.

Baker thought the Santa Fe "marls" and the deposits of the Hueco Bolson might be correlative because of their lithologic similarity, and Bryan (1938: 205) suggested a correlation with the statement:

> The main body of sedimentary deposits of the Rio Grande depression, from the north end of the San Luis Valley to and beyond El Paso, is considered to be of the same general age and to belong to the Santa Fe formation.

Bryan cited no evidence in support of his conclusion and therefore established no formal correlation. Kottlowski (1958: 52) observed that:

> Only about 250 to 400 feet of the Santa Fe group and younger gravels are exposed near El Paso, along walls of the Mesilla and El Paso Valleys and in cut banks of the terraces within the city.

Both Kottlowski and Bryan implied a correlation between the strata in the Mesilla Valley and the El Paso Valley, but neither demonstrated the rocks belonged to the same formation. Although the rocks in the two basins are lithologically similar and chronologically equivalent, this alone is not sufficient proof that they are the same formation.

The older strata in the two basins were deposited in separate bolsons and their constituents largely derived from different sources. Sayre and Livingston (1945: 40) stated that there was nothing in the nature and composition of the older sedimentary rocks in the Hueco Bolson and in the Mesilla Bolson to indicate they had a similar source.

To a limited degree, the younger strata in the two basins did have a similar source because the finest particles in both originated far up the Rio Grande, but the gravel came from local sources, particularly the Organ and Franklin mountains.

Albritton (1938: 1768) considered that the Cenozoic rocks of the Hueco Bolson had no formal name and referred to them as basin fill.

From the foregoing it is clear that the strata in the Hueco Bolson have no formal names. Because the sediments formed in a separate basin, and the rocks are not demonstrably part of a single body continuous with the "Santa Fe Formation" in the Mesilla Bolson, I propose the names "Fort Hancock Formation" and "Camp Rice Formation" for the strata in the Hueco Bolson.

Fort Hancock Formation

The Fort Hancock Formation (new name) is here named for Fort Hancock, a small village in southwestern Hudspeth County, Texas (Fig. 8). The formation is exposed in the Rio Grande Valley in El Paso and Hudspeth Counties, Texas, and adjacent to the Rio Grande in Chihuahua, Mexico. The most extensive outcrops are in Campo Grande, Diablo, and Madden arroyos in Hudspeth County (Fig. 5 and Pl. I).

Typical exposures are in the Madden Arroyo and the type section is on the east side of the arroyo in the NW¼ NW¼ Sec. 19, T. 7, Blk. 73, Hudspeth County, Texas (Fig. 8, Loc. 3). The type locality, 3.5 miles S. 84° W. of Finlay, Texas, may be reached by following the graded road along the south side of the railroad west of Finlay to the Madden Arroyo, thence down the arroyo

Fig. 5. Contact of Fort Hancock and Camp Rice Formations, vicinity of type locality of Fort Hancock Formation, Madden Arroyo. Looking south. Mountains in distance in Mexico. Width of view at contact about 200 yards.

for one mile, at which point the measured section is to the east.

TYPE SECTION OF THE FORT HANCOCK FORMATION, MADDEN ARROYO

Camp Rice Formation
Unconformity

	Thickness (feet)
9. Claystone, tough, pale reddish-brown (10R 5/4); massively bedded; prominent shrinkage cracks on surface	10.3
8. Clayey very fine sandstone, friable, pale yellowish-brown (10YR 6/2); bedding is irregular to cross-bedded; forms steep slopes or cliffs	12.1
7. Silty claystone, tough, color varies from moderate brown (5YR 4/4) to pale yellowish-brown (10YR 6/2) to moderate greenish-yellow (10Y 7/4); weathers to form typical badlands topography	18.6
6. Siltstone, tough, pale yellowish-brown (10YR 6/2); contains vertebrate fossils, particularly rodents	3.8
5. Silty claystone, tough, pale grayish-red (10R 5/2); weathers to pale red (10R 6/2), forms slopes	2.0
4. Silty claystone, tough, grayish pale-red (10R 5/2) to yellowish-gray (5Y 7/2); forms slopes	9.2
3. Silty claystone, tough, grayish-red (10R 4/2); silt lenses up to 3.5 feet thick; incipient cross-bedding; steep slopes with indurated masses of silt protruding	10.3
2. Slightly clayey siltstone, friable; grayish orange-pink (5YR 7/2); forms steep slopes with irregular masses of silt on exposed surfaces	4.1
1. Silty claystone, tough, pale yellowish-brown (10YR 6/2); forms slopes	6.3
Total	76.7

A reference section (measured section 7) is on the east side of Campo Grande Arroyo in the SE¼NE¼ Sec. 9, T. 7, Blk. 74, Hudspeth County, Texas.

Outcrops of the Fort Hancock occur at intervals in the El Paso Valley from the City of El

Paso to the southern end of the Quitman Mountains. The formation has a tabular shape and is at least 100 miles long, 20 miles wide, and 350 feet thick. A composite exposed section reveals a thickness of about 350 feet, but the maximum thickness measurable at any single outcrop is approximately 80 feet.

The Fort Hancock consists of horizonal strata composed of bentonitic claystone, siltstone, and silt, ranging in color from grayish-red to shades of brown and occasionally to greenish-yellow, with yellowish-brown most common (Fig. 6). Few single strata are more than 15 feet thick; the average is approximately 8 feet. Traced laterally, a stratum normally lenses out or grades into a different lithic type within a mile or less. In some localities cross-bedded lenses of silt interrupt the even bedding (Fig. 4).

In many places gypsum is associated with the strata, usually in the form of selenite, which occurs in veins or laminae, or is disseminated through a stratum. Highest concentrations are in the southeastern part of the bolson, from near McNary to the eastern extremity of the basin.

The lower boundary of the formation is not exposed, but the upper limit is an unconformity which separates the Fort Hancock from the overlying Camp Rice Formation. The formations are readily distinguishable because the Camp Rice is composed of sand, gravel, and silt, which are irregularly bedded in the lower part and have a lighter color than the Fort Hancock. The unconformity occurs at the top of unit 9 in the type section and at the top of unit 6 in the reference section (measured section 7). The lithologic differences between the two formations are clearly discernible at any locality where the contact is visible, and are particularly well displayed at the junction of the Campo Grande and Diablo arroyos (Fig. 7).

Exposures of the Fort Hancock form typical badlands-type topography (Fig. 6), unless they are protected by the overlying Camp Rice where they form steep slopes. Even on these slopes a

Fig. 6. Upper 50 feet of Fort Hancock Formation illustrating characteristic badlands-type topography and bedding. View looking south from east side of Madden Arroyo at type locality.

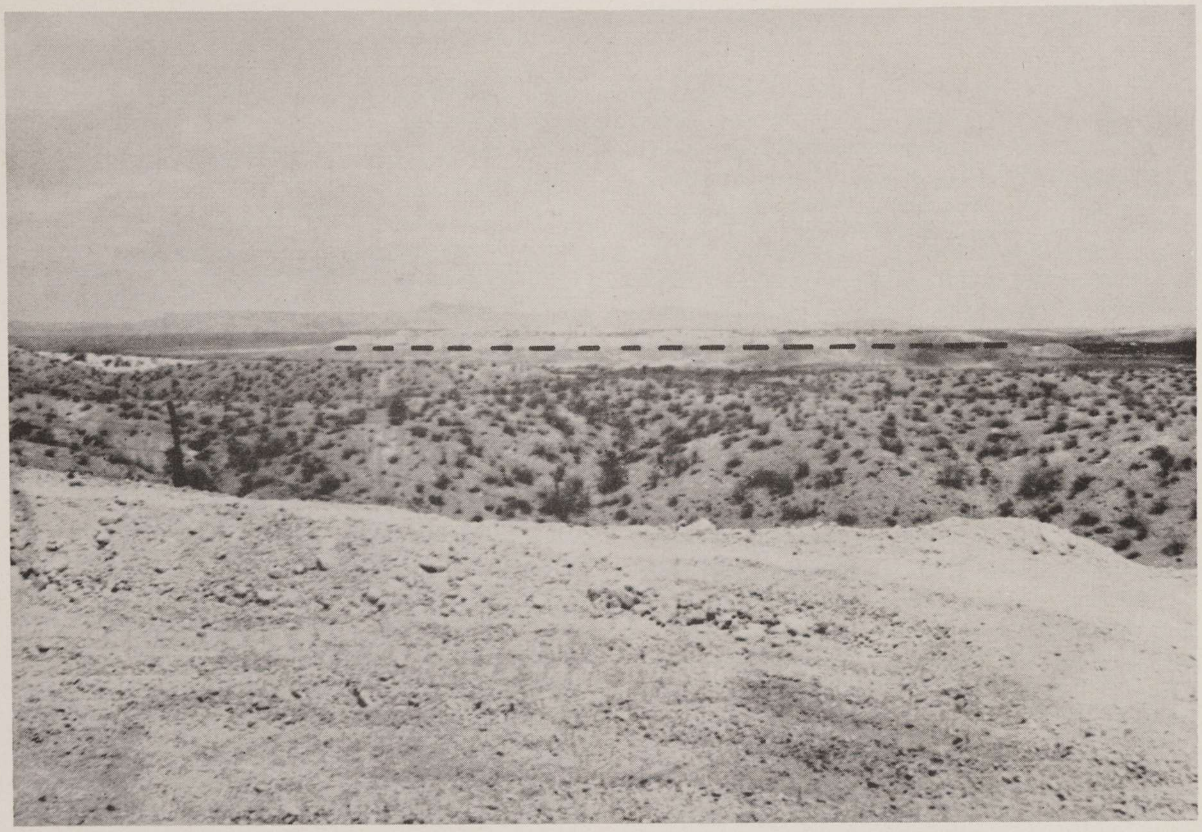

Fig. 7. Contact of Fort Hancock and Camp Rice Formations (dashed line) showing distinct color change. Outcrop at junction of Campo Grande and Diablo Arroyos. View looking northeast toward Finlay Mountains in distance. Width of view about one mile.

loose weathered zone tends to obscure most of the details of bedding. Vertical exposures formed by caving of cliffs generally show shrinkage cracks half an inch or more wide, which form blocks or irregularly shaped masses of varying size, but commonly less than a foot in greatest dimension.

Fossils are extremely rare in the Fort Hancock, but I have found remains of rodents and turtles which constitute a local assemblage of the Blancan Fauna and establish the age of the upper part of the Fort Hancock Formation as probably Aftonian.

Camp Rice Formation

The Camp Rice Formation is here named for the Camp Rice Arroyo (Fig. 8 and Pl. I), an intermittent tributary of the Rio Grande in western Hudspeth County. Typical exposures are in the Rio Grande Valley in El Paso and Hudspeth Counties, and along the escarpment southwest of the river in Chihuahua, Mexico. The most extensive outcrops of the Camp Rice occur in the Alamo, Camp Rice, Campo Grande, Diablo, Madden, and Balluco arroyos in Hudspeth County, Texas.

The type section is in the Campo Grande Arroyo in the NE¼ NE¼ Sec. 46, T. 6, Blk. 74, Hudspeth County (Fig. 8, Loc. 5). At a point 5 miles north of McNary on the county road, the type section is on the east side of the arroyo. Because of the variation in the aspect of the Camp Rice, I have established three reference sections. Two are in Campo Grande Arroyo: measured section 6 in the NE¼ NW¼ Sec. 3, T. 7, Blk. 74, and measured section 8 in the SE¼ NE¼ Sec. 9, T. 7, Blk. 74. Both are on the east side of the arroyo and within three miles of the type section. A third section is in the U-shaped arroyo one-fourth mile south of the west end of the Finlay railroad cut. It is in the NW¼ NE¼ Sec. 20, T. 7, Blk. 73, and is measured section 2.

TYPE SECTION OF THE CAMP RICE FORMATION
CAMPO GRANDE ARROYO

Top of escarpment

	Thickness (feet)
8. Caliche, dense, but platey in upper part; very pale orange (10YR 8/2)	4.0
7. Fine sandstone, poorly sorted, friable; light brown (5YR 6/4) at base grading upward to very pale orange (10YR 8/2); calcareous cement increasing upward to caliche of unit 8; forms moderate slopes	5.0
6. Fine sandstone, moderately sorted, friable; light brown (5YR 6/4); weathers to grayish orange-pink (5YR 7/2); surface tends to develop vertical ridges	5.5
5. Medium sandstone, poorly sorted, friable; bedding indistinct; pale reddish-orange (10R 6/4) weathering to moderate orange-pink (10R 7/2); scattered caliche concretions about 1 cm. in diameter; forms steep slopes	24.6
4. Silty claystone, tough, grayish orange-pink (10R 8/2); weathered surface steep with incipient ledges	3.7
3. Clayey fine sandstone, poorly sorted, friable to loose; moderate reddish-orange (10R 6/6); forms steep slopes with poorly defined ledges	25.5
2. Medium sandstone, moderately sorted, friable to loose; pale yellow-brown (10YR 6/2); forms low-angle slopes	11.0
1. Fine sandstone, well sorted, friable, cross-bedded; yellowish-gray (5Y 7/2) weathering to mottled pale yellowish-brown (10YR 6/2); irregular ledges on weathered surface. Contains vertebrate fossils	9.0
Total	88.3

Unconformity

Throughout the El Paso Valley, the Camp Rice Formation forms the escarpment on both sides of the river. The formation is tabular, about 90 feet thick, and its horizontal dimensions are essentially those of the Hueco Bolson.

The Camp Rice is a collection of gravel, sand, silt, volcanic ash, and caliche. There is a range of color from very light gray through shades of pink and orange to light brown. The strata are horizontal and rest disconformably on the Fort Hancock Formation. In the type section the basal unit of the formation is a friable sandstone, but at various other localities the lowest unit is a sandy cobble gravel. At their contact the two formations are markedly different because the Camp Rice is unevenly bedded, has a coarser grain size, and is a lighter color than the Fort Hancock. The top of the Camp Rice Formation is a surface of ero-

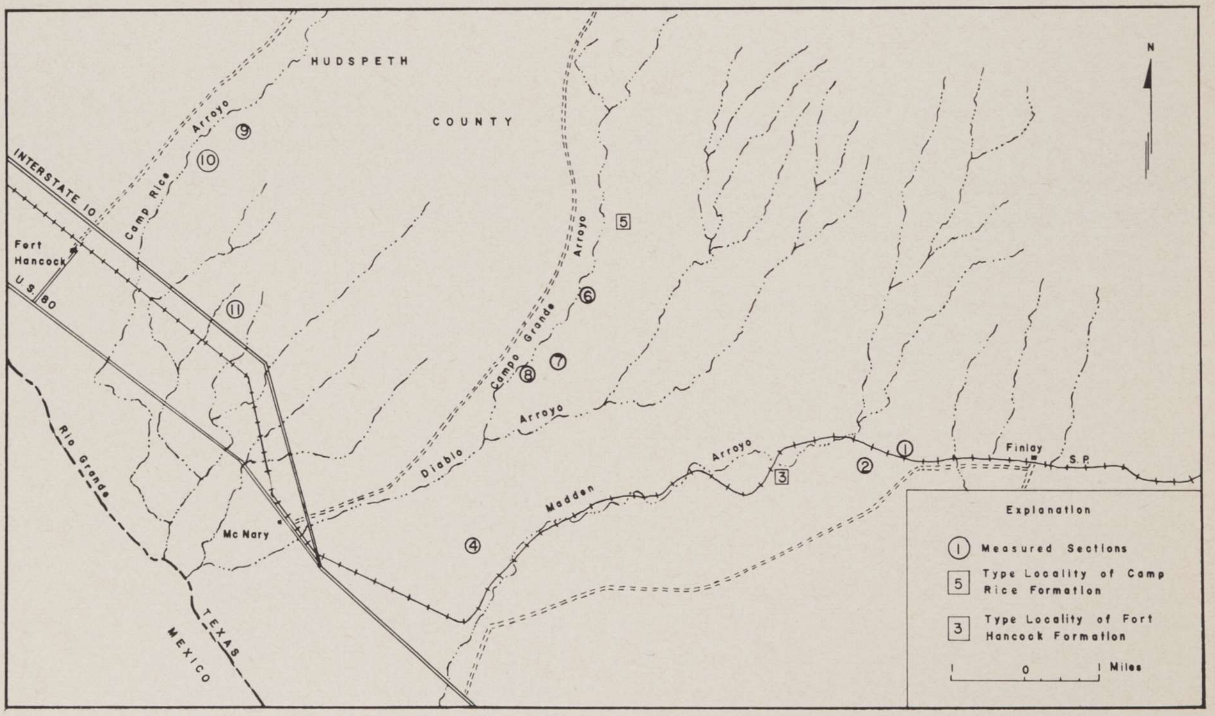

Fig. 8. Type localities and measured sections.

sion which generally slopes (2° to 3°) toward the Rio Grande.

Pearlette volcanic ash occurs in discontinuous lenses and crops out in and near the railroad cut west of Finlay (measured section 1) and in Campo Grande Arroyo (measured section 6). Channel gravel is common in the lower part of the Camp Rice and particularly good exposures begin north of Fort Hancock and extend eastward to north of McNary. Similar gravel also crops out in the Madden Arroyo in the vicinity of the Madden railroad siding.

Grayish orange-pink to light brown, poorly to moderately well bedded siltstone constitutes a small part of the Camp Rice. Rocks of this aspect crop out in the area a quarter of a mile south of the west end of the Finlay railroad cut. At most exposures diastems, which probably represent both aeolian and fluvial scour, separate the different beds, especially the volcanic ash.

Caliche, related to the present climatic cycle, forms the highest stratum in the formation. At the surface it forms an indurated layer as much as 6 feet thick, but the carbonate content diminishes downward, and the caliche vanishes within 10 or 15 feet. Nodules and incipient bands of caliche are characteristic of some exposures in the upper levels of the Camp Rice, but no well-bedded caliche layers occur other than at the surface.

Typical Camp Rice outcrops form steep slopes and, where unprotected by the caliche, form badlands-type topography. There is an excellent example of this type of terrain immediately south of the railroad cut west of Finlay. If the slope of the outcrop is not vertical, a loose weathered zone 2 or 3 inches thick obscures the character of the bedding.

Normal faults, with the downthrown side toward the axis of the basin, displace the Camp Rice and the Fort Hancock at several localities. In the area immediately south of Campo Grande Mountain, the Camp Rice abuts against the Fort Hancock, but the lack of a key bed makes it difficult to determine the amount of throw of the fault. A rough estimate, based on the assumed displacement of the top of the Fort Hancock, suggests a throw of about 200 feet. The fracture, here called the Campo Grande fault, is traceable westward through the Camp Rice Arroyo to the Alamo Arroyo. Small normal faults cut the valley fill at several places, but most have a small throw, less than 30 feet, and are discernible for only a short distance. Only the Campo Grande fault displays a scarp.

The age of the lower part of the Camp Rice is probably Aftonian, the middle part is late Kansan, and the upper part is undetermined. Fossils are extremely rare in the Camp Rice, but I have found camel, horse, sloth, tapir, deer, *Geochelone*, and glyptodont remains which indicate that the age of the sand and gravel of the lower part is almost certainly Aftonian. Higher in the formation the Pearlette Ash, late Kansan (Hibbard, 1956: 146, and Frye and Leonard, 1957: 8), determines the age of the middle part as late Kansan. The presence of the ash in the Camp Rice provides, for the first time, a precise horizon for correlating the Pleistocene strata in the El Paso Valley with the Great Plains stratigraphic sequence. I found no means of determining the age of the Camp Rice above the Pearlette Ash.

Fauna of the Fort Hancock and Camp Rice Formations

Fossils are scarce in the Fort Hancock and Camp Rice formations. The teeth, bones, shells, and seeds that I found compose the only reported collection suitable for dating the strata. The assemblage includes vertebrate fossils, half a dozen grass seeds, and some fresh water mollusks. Because of their long geologic range, the seeds and mollusks are not suitable for precise dating. The vertebrate remains are few, but are adequate for establishing the age of the Fort Hancock and Camp Rice formations. The fossil assemblage is a local representative of the Blancan fauna (Strain, 1959) that lived during the late Pliocene and early Pleistocene and is here named the "Hudspeth local fauna."

HUDSPETH LOCAL FAUNA

Faunal List

Reptilia
- TESTUDINIDAE gen. sp. undet.
- *Gopherus huecoensis* Strain, n. sp.

Mammalia
- *Scalopus* sp.
- *Megalonyx* sp.
- *Glyptotherium* sp.
- LEPORIDAE gen. sp. undet.
- *Sigmodon hudspethensis* Strain, n. sp.
- *Geomys paenebursarius* Strain, n. sp.
- *Citellus mcgheei* Strain, n. sp.
- *Citellus finlayensis* Strain, n. sp.
- *Equus* (*Plesippus*) *idahoensis* Merriam
- *Equus* (*Plesippus*) *simplicidens* Cope
- *Asinus* cf. *cumminsii* (Cope)
- *Nannippus phlegon* (Hay)
- *Equus* sp.
- *Tapirus* cf. *copei* Simpson
- *Tanupolama* sp.
- *Gigantocamelus* sp.
- *Odocoileus* sp.

Hudspeth Local Fauna of Camp Rice Formation

Reptilia
- TESTUDINIDAE gen. sp. undet.

Mammalia
- *Megalonyx* sp.
- *Glyptotherium* sp.
- *Equus* (*Plesippus*) *idahoensis* Merriam
- *Equus* (*Plesippus*) *simplicidens* Cope
- *Equus* sp.
- *Nannippus phlegon* (Hay)
- *Asinus* cf. *cumminsii* (Cope)
- *Tapirus* cf. *copei* Simpson
- *Tanupolama* sp.
- *Gigantocamelus* sp.
- *Odocoileus* sp.

Hudspeth Local Fauna of Fort Hancock Formation

Reptilia
- TESTUDINIDAE gen. sp. undet.
- *Gopherus huecoensis* Strain, n. sp.

Mammalia
- *Scalopus* sp.
- LEPORIDAE gen. sp. undet.
- *Sigmodon hudspethensis* Strain, n. sp.
- *Geomys paenebursarius* Strain, n. sp.
- *Citellus mcgheei* Strain, n. sp.
- *Citellus finalyensis* Strain, n. sp.

The faunal list of the Fort Hancock Formation differs conspicuously from that of the Camp Rice Formation because it includes small burrowing mammals and the chelonid *Gopherus*. The smaller species of *Gopherus* that are living today are burrowing animals, but because of its large size (about two feet long) *G. huecoensis* is not likely to have had that habit. Probably the most logical explanation for the variance in fauna is a difference in depositional environment. The fossil-bearing Camp Rice strata represent stream channel activity, whereas the silt in the Fort Hancock Formation was deposited in a lacustrine or playa

environment. Small bones are likely to be destroyed in a stream, but in silt the small bones may be preserved because the animals burrowed into it when it was exposed as a soil or subsoil. The most plausible explanation of the occurrence of the *Gopherus* with the small animals is that it was covered, *in situ*, by the accumulating silt. The absence of larger animal remains in the Fort Hancock strata may be attributed to lack of preservation or to the fact that they were not encountered in the limited exposures available for examination.

Age of Hudspeth Local Fauna

The fauna described in the following discussion is here named the "Hudspeth local fauna" and identified as a member of the larger Blancan fauna. The Blancan fauna lived during the Blancan Age (Wood *et al.*, 1941: 13; Hibbard, 1950: 182 and 1958: 8) which is a provincial time term encompassing the duration of the Blancan fauna and its contemporaries. Wood (Wood *et al.*, 1941) thought the fauna lived only during the late Pliocene, but Hibbard (1950: 182 and 1958: 8) and Meade (1945: 518) have shown that it lasted into early Pleistocene. In its present usage, the Blancan Age includes both late Pliocene and early Pleistocene.

Cope (1893) first recorded the Blancan fauna and numerous writers (McGrew, 1944, 1948; Hibbard, 1941a, 1958; Meade, 1945; Johnston and Savage, 1955) subsequently discussed it. Wood *et al.*, (1941: 13) defined the Blancan Age (late Pliocene) as the time range of *Borophagus, Ceratomeryx, Ischyrosmilus,* and *Plesippus,* which he listed as index fossils, and as the time of the last appearance of *Nannippus, ?Neohipparion, Lutravus, Anancus=Stegomastodon,* and *Megatylopus =Gigantocamelus.* McGrew (1948: 549) considered *Plesippus=Hippotigris, Borophagus,* and *Procastoroides* to be diagnostic of the Blancan fauna.

Plesippus, Nannippus, Stegomastodon, Gigantocamelus, Borophagus, Ischyrosmilus, Ceratomeryx, and *Lutravus* are now recognized (Hibbard, 1958: 7) in rocks of Pleistocene age. By definition then (Wood *et al.*, 1941), Blancan Age includes the time range of faunas which lived in the late Pliocene and early Pleistocene. Any fauna which contains both *Nannippus* and *Plesippus* is Blancan and the association of these genera is indicative of Blancan Age (Hibbard, 1958: 8).

The Hudspeth local fauna includes *Nannippus* and *Plesippus,* which date it as Blancan. Other common Blancan genera present are *Gigantocamelus, Tanupolama, Megalonyx, Glyptotherium,* and *Gopherus.* Some typical Blancan genera, including *Borophagus, Procastoroides, Stegomastodon, Platygonus, Hypolagus,* and *Camelops,* are absent. Their absence may be explained by supposing that (a) these genera did not live nearby; or (b) their remains were not preserved; or (c) their bones are still buried or have already been destroyed by weathering and erosion.

The first and second of the explanations are probably the least likely. So many of the other elements of the fauna are present that it is logical to suppose that almost all genera typical of the fauna lived there and were equally likely to be preserved. No doubt the third possibility explains, to a large degree, the paucity of bones. In the presence of the gypsum in the strata, many of the fossils rapidly disintegrate when exposed to surface moisture. Additionally, outcrops are limited mostly to steep slopes, whereon fossils are broken, scattered, and washed away.

Although the Hudspeth local fauna is of Blancan Age, it is important to determine whether its age is late Pliocene or early Pleistocene, or encompasses the two. The fauna contains neither a species previously proven to be limited to the late Pliocene nor a species demonstrated to be restricted to the Pleistocene.

The part of the Hudspeth fauna from the Fort Hancock Formation is an assemblage different from that from the Camp Rice Formation. Because the two formations are separated by an unconformity, the age of one part of the fauna could be late Pliocene and of the other, early Pleistocene, or the age of both could be either late Pliocene or early Pleistocene. The Hudspeth fauna is certainly older than late Kansan because it lies, without evidence of structural deformation, beneath the Pearlette Ash which was deposited during the retreat of Kansan glaciation.

Adjustment of the fauna to a particular climate should be partly indicative of its age. If it can be demonstrated that the Hudspeth fauna was adjusted to a warm climate, its age would be late Pliocene, or possibly Nebraskan (Hibbard, 1960: 17), or the first interglacial age (Aftonian) of the Pleistocene. If it were adjusted to a cool climate, its age would be Kansan. The collected fossils do

not include remains of microtine rodents or other cool climate animals, but do include bones of warm-climate forms. Among these are *Gopherus* and other large chelonids, *Sigmodon*, and *Tapirus*, all of which are restricted to warm climates today. Of the genera listed above, the chelonids have probably been used most frequently as indicators for warm climates of the past (Hibbard, 1960: 6; Brattstrom, 1961: 553).

Probably the presence of the above-listed animals indicates a warm climate and demonstrates that the Hudspeth local fauna lived during a time in which there were no severe winters. For all that, we have no definite knowledge of the temperature range or climate of Trans-Pecos Texas during Nebraskan Age, and we have not identified the Nebraskan Stage in that area. On the basis of climate we can only say that the fauna may be either late Pliocene or early Pleistocene.

Another approach to dating of the fauna is through the evaluation of the evolutionary stage of the species. In this respect the gophers offer usable evidence. *Geomys* developed ever-growing cheek teeth from rooted teeth during late Pliocene (Hibbard, 1954: 356). The gophers in the Hudspeth fauna have rootless teeth and are therefore late Pliocene or younger. The close relationship of *Geomys paenebursarius* Strain, n. sp., to the living *G. bursarius* makes logical the assumption that its age is more likely to be early Pleistocene than late Pliocene.

Although the evidence is not conclusive, the Hudspeth fauna probably lived during the Aftonian Age of the Pleistocene, for it was adjusted to a warm climate and is older than the Pearlette Ash of late Kansan Age.

Correlation with Other Blancan Local Faunas

It is not feasible at this time to correlate the Hudspeth local fauna with any of the local faunas of Blancan Age. The only species in the Hudspeth fauna which are identical to those of other local faunas are *E. (Plesippus) simplicidens* and *Nannippus phlegon*. Both these long-ranging forms span the entire Blancan and are of little value for detailed correlation.

Systematic Paleontology

Class REPTILIA

Order TESTUDINATA

Family TESTUDINIDAE

Gopherus huecoensis Strain, n. sp.

Pls. II, III, IV, V, VI

Type. Plastron and various appendicular skeletal elements of the same individual, B.E.G. 40240–27.

Formation and locality. Lower Pleistocene, Fort Hancock Formation, Madden Arroyo, locality B.E.G. 40240, NW¼NW¼ Sec. 19, T. 7, Blk. 73, Hudspeth County, Texas. Pale yellow silt four feet thick, 111.0 feet below top of caliche on east side of arroyo.

Diagnosis. A *Gopherus* larger than any living North American species; ratio of width of plastron to length of plastron 79.7 percent; plastron smooth and thin; epiplastral lip elliptical and only slightly breaking the contour of the anterior lobe; epiplastron flattened dorsally and deeply excavated behind; no epiplastral notch; entoplastron subhexagonal and the gular scutes extend almost to its center; xiphiplastral notch angular.

Material. Plastron, pectoral girdle, front limbs and feet, right femur, right tibia, pelvis, dermal ossicles, and other skeletal elements not well enough preserved to be described.

Description. The plastron (Pl. II) is preserved except for the right hypoplastron of which the peripheral portion is missing. The plastron is quite flat, thin, and without sculpture. Near the lateral margin the hypoplastra are 8.0 mm. thick. On the left side the bridge is 265 mm. long. The length of the plastron along the midline suture is 495 mm. The apices of the xiphiplastron lie 35 mm. beyond the termination of the midline suture, giving the plastron a total length of 530 mm. The width of the plastron measured across the anterior portion of the hypoplastra is 395 mm. and is 77.77 percent of the midline length. The anterior lobe is 265 mm. wide and 150 mm. long. These measurements indicate the anterior lobe to be 30.3 percent of the midline length of the plastron. There is no epiplastral notch. The epiplastron rises slightly above the general level of the plastron and has a regularly rounded outline which only slightly breaks the general contour of the anterior lobe when viewed from below, but a dorsal view shows a slight flare in the epiplastral lip. The epiplastral lip thickens backward for a distance of 54 mm. at which point it is 32 mm. thick. Posteriorly the epiplastron is excavated to a depth of 13 mm., forming a cavity

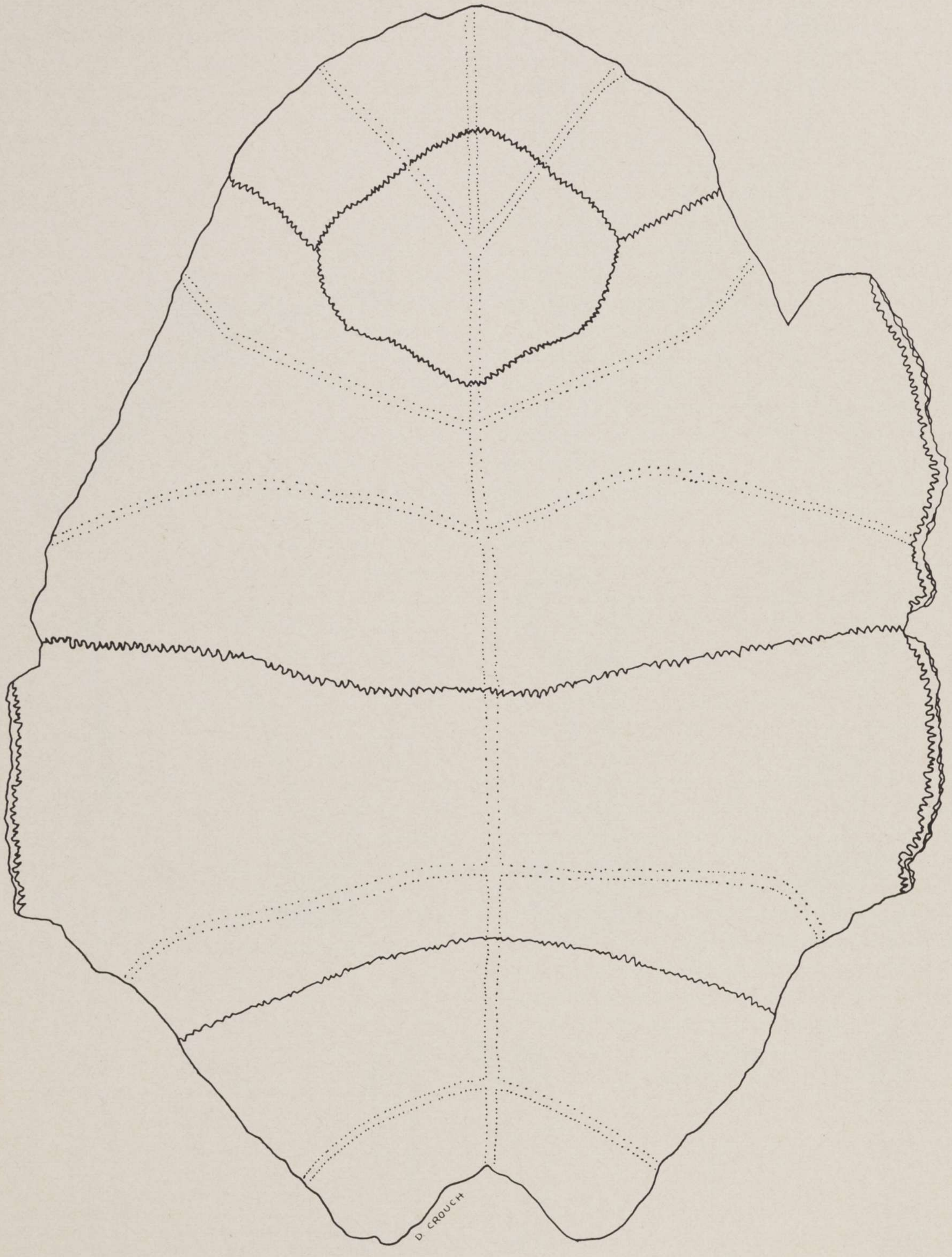

PLATE II

Gopherus huecoensis Strain, n. sp.

About six-tenths natural size.

Plastron, ventral view, B.E.G. 40240–27, type.

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PLATE III
Gopherus huecoensis Strain, n. sp.

which is 94 mm. wide and has a vertical dimension of 17 mm. The overhanging lip thus formed is 11 mm. thick. The epiplastral lip is almost flat on the dorsal side, but is convex on the ventral surface. At the posterior dorsal symphysis there is a slight notch (Pl. VI, Fig. 1). Beginning at a distance of about 10 mm. on either side of the midline, the posterior dorsal border of the epiplastral lip is beveled on the upper border in such a way that a shallow sulcus with slightly raised borders is formed. This sulcus is about 10 mm. wide and continues posteriorly to the extremity of the anterior lobe. There is no indentation in the free border of the epiplastron where the gulo-humeral sulcus intersects it. The sulci are 130 mm. apart at this point.

The entoplastron is wider than long, measuring 125 mm. by 113 mm., respectively. It is roughly hexagonal and the gulo-humeral sulci extend backward almost to its center. If the length of the gulo-humeral sulci be taken as the radius of a circle whose center is their point of intersection on the entoplastron, the arc of the circle thus circumscribed would almost exactly coincide with the outline of the epiplastral lip. The posterior border of the entoplastron lacks 17 mm. of reaching the humero-pectoral suture. Along the midline the gular scute has a length of 115 mm., the pectoral 40 mm., the abdominal 152 mm., the humeral 72 mm., the femoral 85 mm., and the anal 40 mm. Measured along the midline suture the hyoplastron is 139 mm. long and the hypoplastron is 91 mm., giving a ratio of length of hyoplastron to length of hypoplastron of 65.43 percent.

The posterior lobe of the plastron is 90 mm. long and 290 mm. wide. Its length is equal to 18 percent of the midline measurement of the plastron. The right margin of the xiphiplastron is nearly straight, but the left has a slight downward curve in the border of the femoral scute. The xiphiplastral notch is 35 mm. deep and the apices of the projections are approximately 90 mm. apart. An angle of 95 degrees is formed by the diverging processes.

On the dorsal side of the xiphiplastron there is a prominent transverse groove at the base of each projection. These sulci separate the projections, which are dorsally convex, from a transverse ridge at the midline termination of the plastron. The posterior border of this ridge is rather abrupt, but anteriorly it diminishes gradually.

The scapulae (Pl. III, Figs. 1, 2) are both broken so that the original length cannot be determined. The greatest diameter at midshaft is 19 mm. The procoracoid process has a maximum midshaft diameter of 22 mm. and measured from the center of the glenoid fossa, it has a length of 90 mm. The two processes of the bone diverge at an angle of about 120 degrees. The width of the glenoid fossa is approximately 20 mm.

The coracoid (Pl. III, Figs. 2, 4) is deltaic in outline and widely expanded at its medial border. It is 100 mm. long, 80 mm. wide at the medial extremity, and 24 mm. in greatest diameter at the base of the flare. At its articulation with the glenoid fossa it is 25 mm. wide.

The humeri (Pl. IV, Figs. 1, 2) are almost complete, only moderately curved, and 158 mm. long. At the distal end the epicondylar width is 60 mm. Near midshaft the bone has a diameter of 18 mm. and a subtriangular cross section. The tuberosities are strongly developed on the proximal end.

The ulnae (Pl. IV, Fig. 3 and Pl. III, Fig. 7) are stout and distinctly curved. They are 91 mm. long. At the proximal end they are triangular with a transverse diameter of 30 mm. and an anteroposterior diameter of 19 mm. At midshaft the bones are triangular in cross section with a maximum diameter of 17 mm. The distal ends of the ulnae are flattened and have a transverse diameter of 32 mm., but an anteroposterior measurement of only 10 mm.

The radii (Pl. III, Fig. 6 and Pl. IV, Fig. 4) are more slender than the ulnae and the distal ends are flattened and expanded to form blade-like terminations which are 36 mm. wide. The proximal ends are subtriangular with a maximum dimension of 26 mm. At midshaft the bones are subtriangular in cross section and the greatest diameter is 13 mm. The length of the radii is 88 mm.

The front limbs and feet (Pl. V) were recov-

PLATE III

Gopherus huecoensis Strain, n. sp.

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Figures—

1. Left scapula of type, B.E.G. 40240–27. One-half natural size.
2. Right coracoid and scapula, lateral view, B.E.G. 40240–27, type. One-half natural size.
3. Left femur, B.E.G. 40240–27, type. One-half natural size.
4. Left coracoid, B.E.G. 40240–27, type. One-half natural size.
5. Left tibia, posterior and left side views, B.E.G. 40240–27, type. One-half natural size.
6. Right radius, posterior and left side views, B.E.G. 40240–27, type. One-half natural size.
7. Right ulna, posterior and left side views, B.E.G. 40240–27, type. One-half natural size.

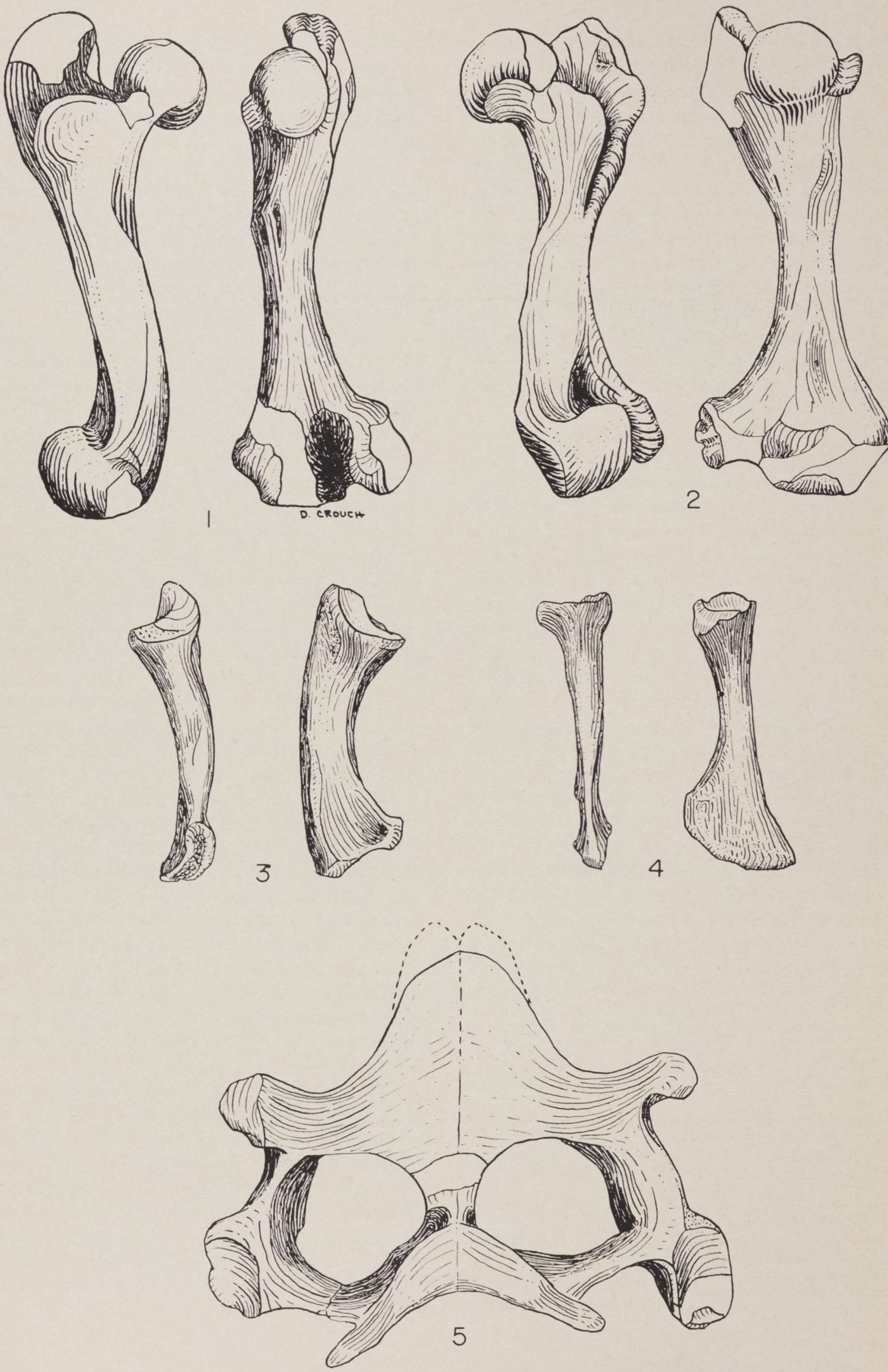

PLATE IV

Gopherus huecoensis Strain, n. sp.

n. n. sp.

ered in an articulated condition and the only element missing was the first digit of the right foot. A number of dermal ossicles were found associated with the feet. Most of the ossicles are rounded and flat, but some are elongate. There are only two phalanges in each digit, a characteristic of all testudine turtles (Auffenberg, 1961: 498). The ungual phalanges are short, stout, and wedge-shaped in the first three toes, but tend to be more elongate and conical in the fourth and fifth. The second phalanx is reduced to a flat disk. The radiale is prismatic, 27 mm. long, and appears to prevent the first carpal bone from articulating with the radius. For most of its length, the radiale articulates with the radius, but its inner proximal margin joins the first centrale. In the left carpus the first and second centrale are fused to form an elongate bone which is constricted in the area of their union. In the right foot these bones are not ankylosed. The first centrale articulates with the radius and the intermedium as well as with the second centrale. The intermedium is subtriangular and is elongate in the long axis of the limb. It is 14 mm. long. The remaining bones of the carpus are compact and short and the foot must have been very short and stout.

The left femur (Pl. III, Fig. 3) is almost straight and is 110 mm. long. The distal extremity is 35 mm. wide at the condyles. At midshaft the least diameter is 15 mm. and the maximum is 20 mm. The greater and lesser trochanters are united by a ridge which rises almost to the height of the capitulum. This ridge is joined to the head by a less prominent keel which in turn encloses a well-developed pit in the proximal end of the bone. The ratio of the length of the femur to the length of the humerus is 69.5 percent.

The left tibia (Pl. III, Fig. 5) is 80 mm. long. At the proximal end its tranverse measurement is 32 mm. and the greatest diameter of the distal extremity is 22 mm. About midshaft the anteroposterior diameter is 11 mm. and the transverse measurement is 14 mm. It is 72.7 percent of the length of the femur.

Most of the pelvis (Pl. IV, Fig. 5 and Pl. VI, Fig. 2) is present except for the ilia which are almost entirely missing and the extremities of the anterior pubic processes which have been destroyed by erosion. It is slightly distorted and the ischium is a little out of alignment. The anterior portion of each pubis is quite thin and the lateral process is short, stout, and expanded on the lower end. These processes are directed outward, upward, and backward. The posterior processes of the ischia are slender and are directed backward and outward. The apices are 86 mm. apart. The ischiopubic foramen is nearly circular, but somewhat flattened on top, and at the anterior border the pubic bone is beveled on the dorsal side. The width of the pelvis measured between the centers of the acetabula is 150 mm. The length measured along the midline from the posterior portion of the ischia to the notch in the pubes is 100 mm. In the region of the symphysis, the ischia are quite thick. The angle made by the symphysis of the ischia with the symphysis of the pubis measured on the upper surface of the bones is about 100 degrees, which may be a few degrees greater than normal because of the distortion.

Discussion. A comparative study of available data indicates that *Gopherus canyonensis* (Johnston) 1937 from the early Pleistocene of the Panhandle region of Texas is the *Gopherus* most closely related to *G. huecoensis.* (Table 1.) *G. huecoensis* can readily be distinguished from *Gopherus canyonensis* because the leg bones of *G. canyonensis* are proportionally much more robust. The limb bones of *G. canyonensis* are only one-third longer than those of *G. huecoensis,* but are more than twice as large at the extremities of the bones. The plastron of *G. canyonensis* could not be located for comparative study, but according to Johnston's (1937) measurements the two differ in that *G. canyonensis* is much larger. Also, the xiphiplastral notch in *G. canyonensis* is rounded, but in *G. huecoensis* it is angular. For these reasons, *G. canyonensis* and *G. huecoensis* are considered to be distinct species.

Gopherus huecoensis was named for the Hueco Bolson, Hudspeth County, Texas.

PLATE IV

***Gopherus huecoensis* Strain, n. sp.**

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Figures—

1. Left humerus, back and left side views, B.E.G. 40240–27, type. One-half natural size.
2. Right humerus, back and right side views, B.E.G. 40240–27, type. One-half natural size.
3. Left ulna, back and right side views, B.E.G. 40240–27, type. One-half natural size.
4. Left radius, back and right side views, B.E.G. 40240–27, type. One-half natural size.
5. Pelvis, ventral view, B.E.G. 40240–27, type. One-half natural size.

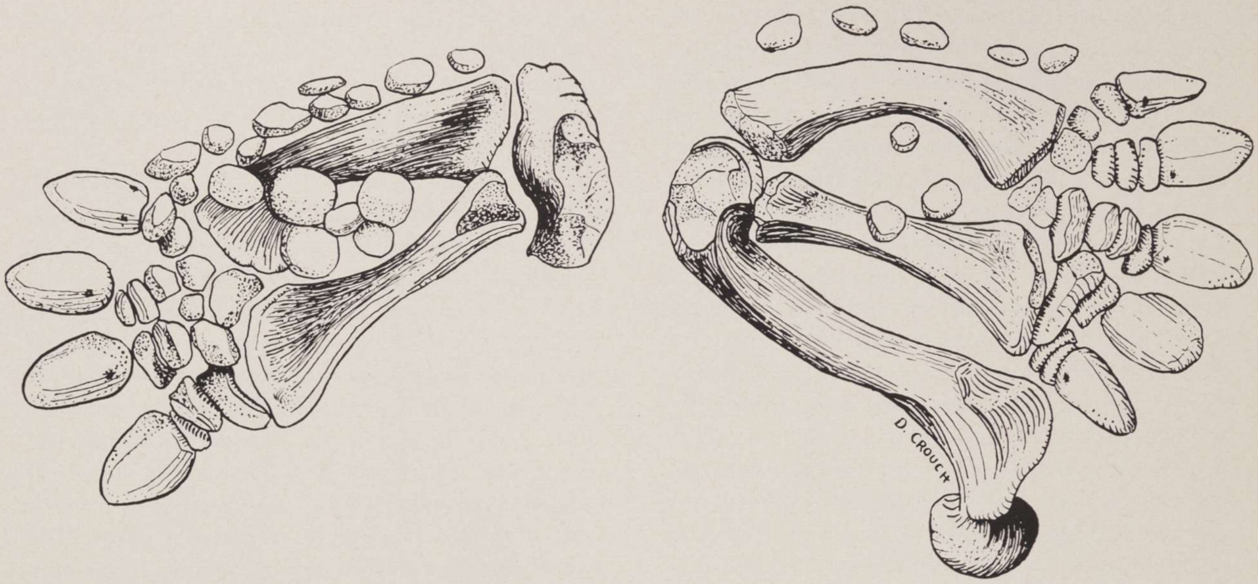


PLATE V
***Gopherus huecoensis* Strain, n. sp.**
Front limbs, front view, B.E.G. 40240–27, type.
About one-half natural size.
p. 24

TABLE 1.

Measurements of Bones of the Type Specimen of *Gopherus canyonensis* and the Type Specimen of *Gopherus huecoensis*

	G. canyonensis	*G. huecoensis*
Length of humerus	238 mm.	158 mm.
Epicondylar width of humerus	94	60
Length of femur	169	110
Anteroposterior diameter of proximal end of femur	80	50
Transverse width of femur at trochanters	69	33
Transverse width of distal end of femur	73	35
Length of tibia	113	80
Transverse width of proximal end of tibia	47.5	32
Width of distal end of tibia	32.5	22
Length of ulna	135	91
Ratio of length of femur to length of humerus	73%	69.5%
Ratio of width of plastron to length of plastron	67%	77%

TESTUDINIDAE gen. sp. undet.

Remains of large chelonids are frequently found in both the Fort Hancock and the Camp Rice formations, but they are so poorly preserved that specific identification is uncertain. The recognition of these large land-dwelling forms is important because their presence implies a warm climate.

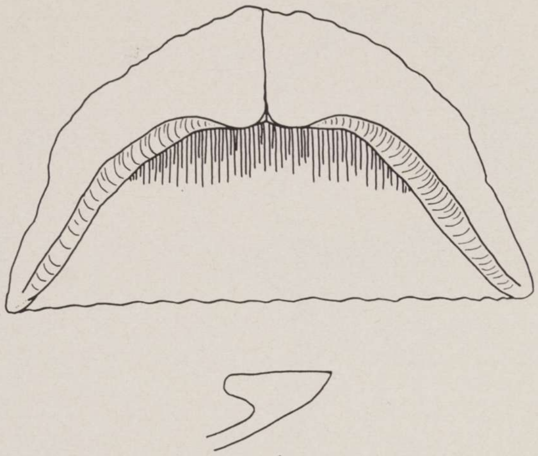
Class MAMMALIA
Order INSECTIVORA
Family TALPIDAE
Scalopus sp.
Pl. IX, Fig. 10

Material. Portions of the humeri, B.E.G. 40240–3. The right humerus is complete, but the proximal end of the left is missing.

Formation and locality. Lower Pleistocene, Fort Hancock Formation, Madden Arroyo, locality B.E.G. 40240, NW¼ NW¼ Sec. 19, T. 7, Blk. 73, Hudspeth County, Texas. Pale yellow silt four feet thick, 111.0 feet below top of caliche on east side of arroyo.

Description. Humerus very similar to S. *aquaticus*, but a little smaller. The ratio of the midshaft width to length is greater in the fossil form. A recent specimen examined has a width to length ratio of 65.5 percent, whereas in the fossil humerus it is 76.6 percent.

Discussion. The fossil specimen is sufficiently similar to *Scalopus* to be included in that genus, but until additional material is available, a more detailed classification would be speculative.



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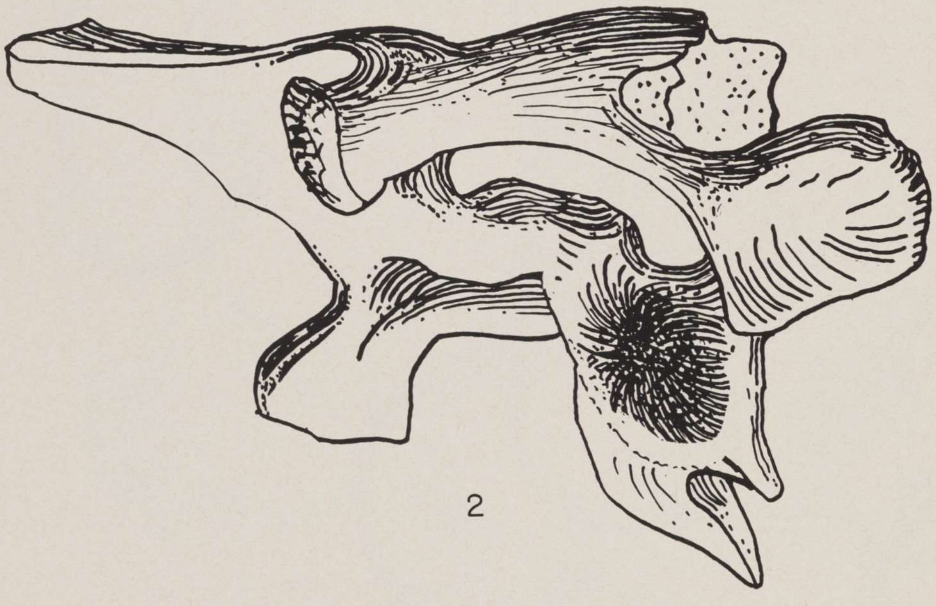

2

PLATE VI

Gopherus huecoensis Strain, n. sp.

p. 24

Figures—

1. Dorsal and sectional view of epiplastral lip of type, B.E.G. 40240–27. One-third natural size.
2. Pelvis, right side view, B.E.G. 40240–27, type. Natural size.

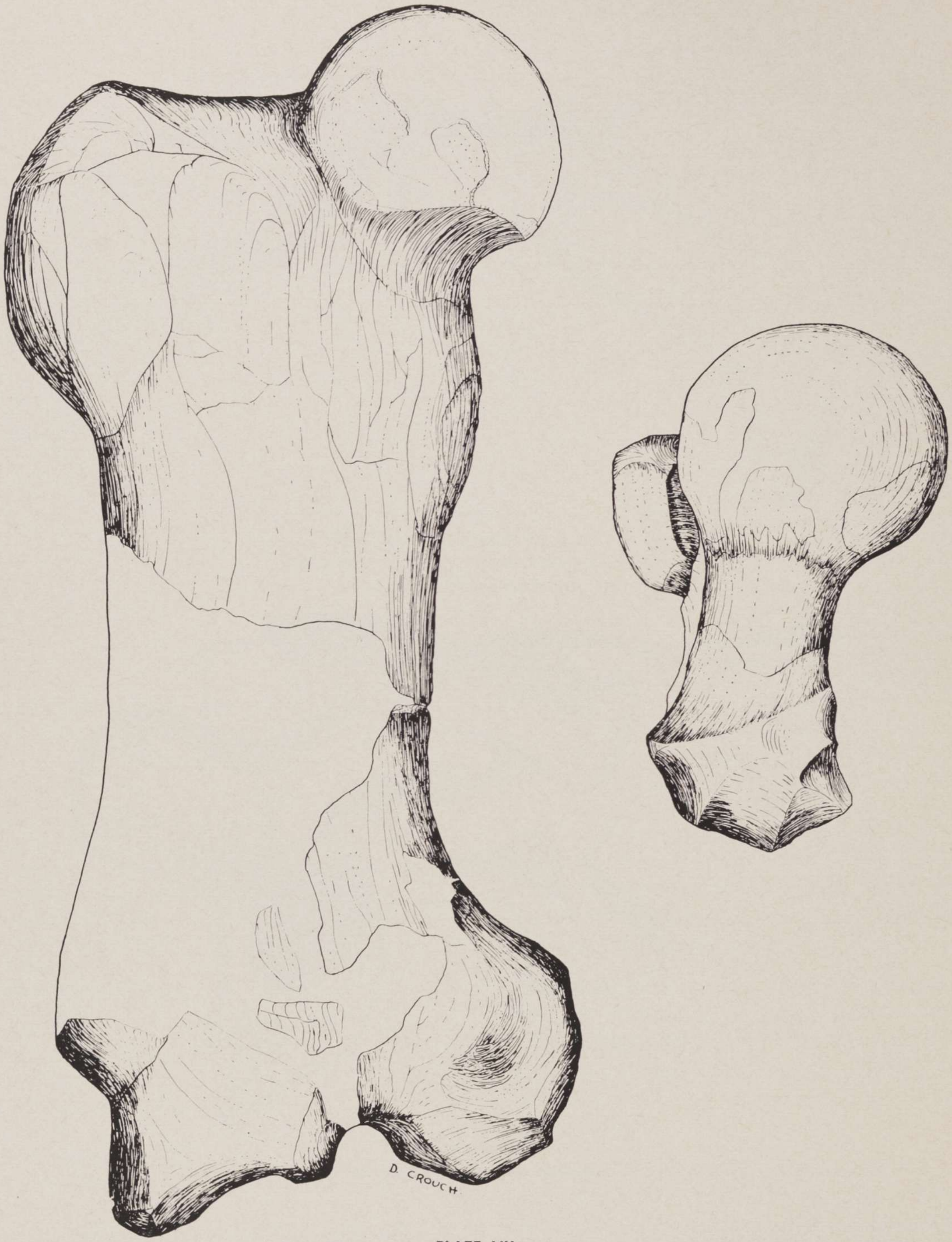

PLATE VII

Megalonyx sp.

Right femur, front and top view, B.E.G. 40241–6. One-half natural size.

p. 33

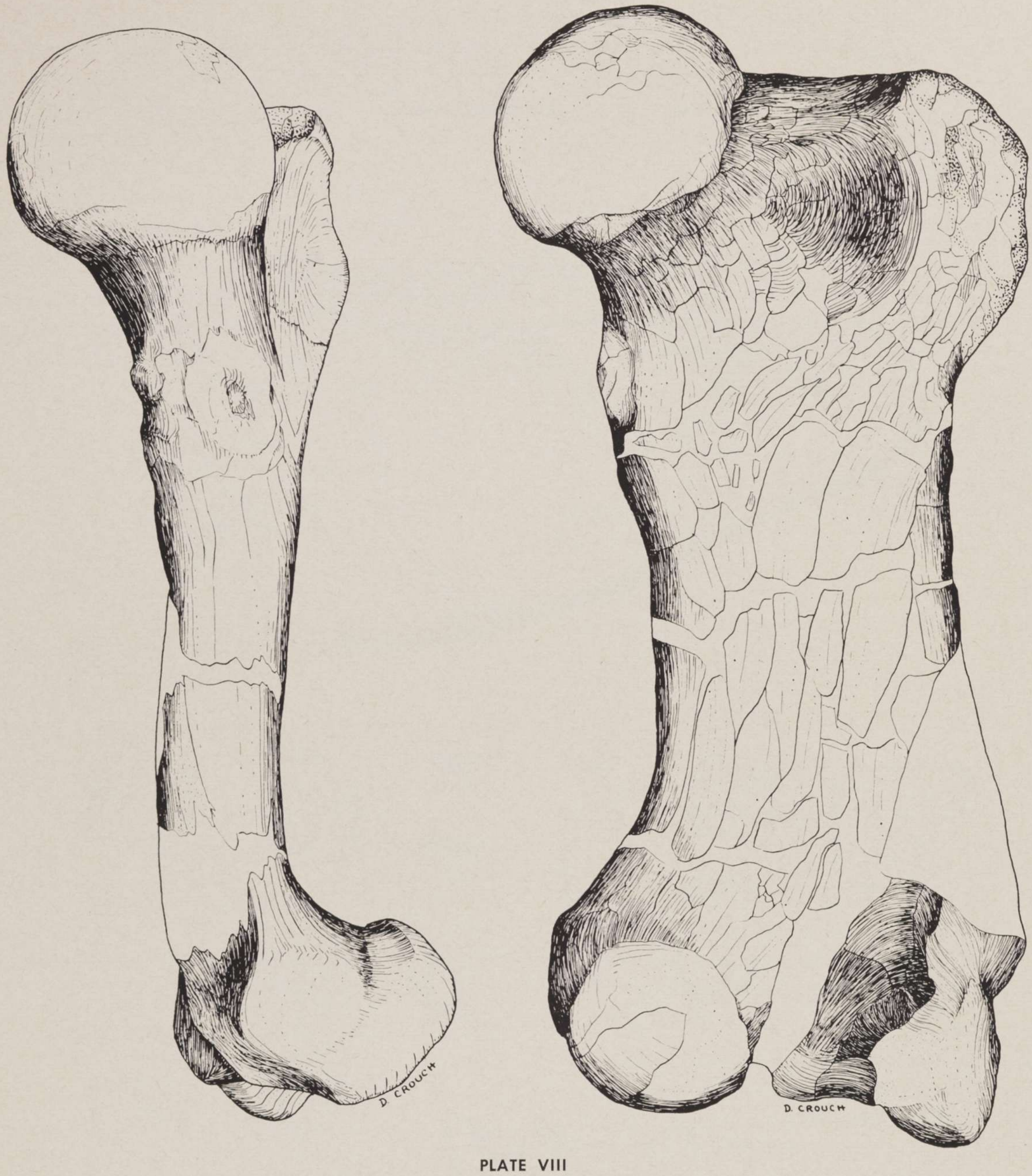

PLATE VIII

***Megalonyx* sp.**

Right femur, left side and posterior views, B.E.G. 40241–6. Slightly less than one-half natural size.

Order EDENTATA
Family MEGALONYCHIDAE
Genus *Megalonyx* Harlan
Megalonyx sp.
Pls. VII, VIII

Material. Right femur, B.E.G. 40241–6.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Campo Grande Arroyo, locality B.E.G. 40241, NE¼ NW¼ Sec. 3, T. 7, Blk. 73, Hudspeth County, Texas. Specimen collected 92 feet below top of caliche.

Description. Because the femur has been damaged, it is impossible to provide more than approximate dimensions. It is 393 mm. long, 178 mm. wide at the proximal end, and 163 mm. wide at

PLATE IX

Figs. 1–9 and 11, one-half natural size.

Fig. 10, twice natural size.

the distal extremity. The midshaft width measured immediately above the third trochanter is 101 mm. and the anteroposterior diameter at the same point is 44 mm. The third trochanter is missing and the condyles are partly destroyed. The lower extremity of the bone is rotated inward at an angle of approximately thirty degrees with respect to a vertical plane passing through the capitulum and the great trochanter.

Discussion. Meade (1945) recognized the genus *Megalonyx* in the Blancan fauna. The specimen provides little information other than to establish the presence of the genus in the local fauna.

Family GLYPTODONTIDAE
Genus *Glyptotherium* Osborn
Glyptotherium sp.
Pl. IX, Figs. 2, 3, 4, 11

Material. Four scutes, B.E.G. 40254–1 to 40254–3, and 40255–2.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Madden Arroyo, locality B.E.G. 40254, SW¼ SE¼ Sec. 17, T. 7, Blk. 73, Hudspeth County, Texas. Gray sand at west end of railroad cut two miles west of Finlay, Texas. Also, Arroyo Balluco, locality B.E.G. 40255, SE¼ SE¼ Sec. 33, T. 7, Blk. 73, Hudspeth County, Texas. Gray sand immediately above reddish-brown bedded silt and clay, 60 feet below escarpment on west side of arroyo.

Discussion. Glyptotherium has been recognized (Wood *et al.*, 1941: 13) for many years as an element of the Blancan fauna. The scutes can serve only to add the presence of glyptodonts in the local fauna.

Order RODENTIA
Family CRICETIDAE
Genus *Sigmodon* Say and Ord, 1825
Sigmodon hudspethensis Strain, n. sp
Pl. X, Figs. 12, 13

Holotype. The lower right first molar of specimen B.E.G. 40240–1, a young adult (Pl. X, Fig. 12A). Paratype lower right first molar of B.E.G. 40240–2, an adult with well-worn teeth (Pl. X, Fig. 13A).

Formation and locality. Lower Pleistocene, Fort Hancock Formation, Madden Arroyo, locality B.E.G. 40240, NW¼ NW¼ Sec. 19, T. 7, Blk. 73, Hudspeth County, Texas. Pale yellow silt four feet thick, 111.0 feet below top of caliche on east side of arroyo.

Diagnosis. A cotton rat about the size of *Sigmodon hispidus* (Say and Ord), but with the first lower molars a little narrower, particularly in front. The anterior external reentrant valley of the first lower molar opens widely to its full depth externally and it is longer, wider, and deeper than the anterior internal reentrant valley. All valleys of the tooth are broad and not as compressed as in living forms.

Material. Isolated upper and lower molar teeth representing at least three individuals from two locations. Specimen 40240–1 is composed of RM_1, RM_2, LM_2, LM^1, LM^2, and RM^2. Specimen 40240–2 consists of RM_1, two RM_3, LM_1, LM_3, broken portions of two RM^1 and two RM^2.

Description. Teeth a little more brachydont than *S. hispidus*. No. 40240–1 probably represents a single individual because the teeth were found associated and all exhibit about the same amount of wear. In M_1 the anteroexternal reentrant valley opens widely and to its full depth on the labial side. It is larger and deeper than the opposite internal one. Furthermore, it is as wide as the anteroposterior diameter of the opposite reentrant

PLATE IX

Figures—		Page
1.	*Equus (Asinus) cf. cumminsii* (Cope) — Left mandibular ramus, left side and occlusal views, B.E.G. 40246–1.	45
2–4, 11.	*Glyptotherium* sp.	35
2.	Scute, dorsal view, B.E.G. 40255–2.	
3.	Scute, dorsal view, B.E.G. 40254–1.	
4.	Scute, dorsal view, B.E.G. 40254–2.	
11.	Scute, dorsal view, B.E.G. 40254–3.	
5.	*Equus (Plesippus) simplicidens* (Cope) — Upper left molar or premolar, B.E.G. 40244–5.	43
6–7.	*Nannippus phlegon* (Hay)	47
6.	Portion of lower right third molar, B.E.G. 40250–9.	
7.	Lower right third molar, B.E.G. 40245–1.	
8–9.	*Equus (Plesippus) simplicidens* (Cope)	43
8.	Upper left molar, occlusal view, B.E.G. 40253–1.	
9.	Upper right molar, occlusal view, B.E.G. 40550–1.	
10.	*Scalopus* sp. — Right humerus, anterior and posterior views, B.E.G. 40240–3.	30

valley and the first internal lophid combined. The external reentrant valleys of M_1 are about the same depth and have a distinct backward bend in the enamel of the posterior wall near their internal extremity. Length of M_1 is 2.5 mm. On the anterior labial margin of M_2 there is a small, elongate, narrow pit bordered anteriorly by a sharp little ridge. A similar feature occurs on M_3 in 40240–2. Length of M_2 is 1.9 mm. The M_1 in the paratype has features identical to the corresponding tooth in the type, but shows more wear. The stage of wear indicates a mature adult. The dentine tract of the anterointernal lophid opens broadly into the dentine of the anterior loop through an isthmus between the anterior external reentrant valleys. M_3 narrows slightly backward which gives it a modified triangular shape. On the anterior labial side of the tooth there is an elongate, narrow pit bordered externally by a sharp ridge. In M^2 the lingual margin of the anterior loph is expanded as is the labial extremity of the posterior loph. The anterior external and internal reentrant valleys are directly apposed and almost meet at the center of the tooth, leaving a narrow dentine strip connecting the anterior and medial lophs. One RM^2 has an accessory cusp, as an outgrowth of the cingulum, situated at the outer extremity of the posterior labial reentrant valley. Because of the number of teeth and the difference in wear, it is probable that at least two individuals are represented in this sample.

The species is named for Hudspeth County, Texas.

Discussion. The material here described can be distinguished from living species by the following comparisons: the valleys of the lower teeth are wider and less compressed than in recent forms and, in general, the enamel loops of the fossil teeth are more expanded; the reentrant valleys are not as deep and make lower angles with the tooth margins than in forms now extant; in M_2 the small deep valley with a sharp ridge on its outer border is on the labial side of the anterior border of the fossil specimen, but in the living form at hand, it is on the anterior portion of the labial wall, where its axis makes an angle of about 45 degrees with the front border of the tooth. On M_3 a similar structure cuts obliquely across the anterior outer corner of the tooth. This same feature occurs in modern teeth, but is more prominent. In M_2 of the holotype, the anterointernal loph is more expanded on the lingual side and not as elongate as in the living form. The anterior margin of M_3 is concave in the fossil form in contrast to an almost straight margin in the recent M_3.

Sigmodon hudspethensis can be distinguished from *S. intermedius* Hibbard (1941a) because the anterior external reentrant valley in M_1 is deeper than in *S. intermedius.* Also, it opens broadly to the outside in *S. hudspethensis,* but in the type of *S. intermedius,* moderately heavily worn, it is closed to the outside and thus becomes a pit. In addition, M_1 of *S. hudspethensis* is more triangular and more robust (about 10 percent larger) than *S. intermedius.*

S. hilli Hibbard (1941b) is differentiated from *S. hudspethensis* by the fact that in the type of *S. hilli* the anterior external reentrant valley is not broadly open to the labial side as in *S. hudspethensis.* Also *S. hudspethensis* has more triangular and more robust lower first molars.

S. hudspethensis can be quickly distinguished from *S. medius* Gidley (1922) because the anterointernal reentrant valley of M_1 is deeper than the outer one in *S. medius,* but just the opposite is true in *S. hudspethensis.* Also, in *S. medius* the posterior portion of the lingual wall of M_3 makes a sharp right angle with the posterior wall of the internal reentrant valley, and according to Gidley, this same feature is present in *S. curtisi* Gidley and *S. minor* Gidley. Because this feature of M_3 does not occur in *S. hudspethensis,* it serves to distinguish *S. hudspethensis* from the three forms described by Gidley.

Family GEOMYIDAE

Geomys paenebursarius Strain, n. sp.

Pl. X, Figs. 1–8

Holotype. B.E.G. 40240–10, portion of left ramus containing cheek tooth series, but with the incisor and ascending ramus broken. Paratype, B.E.G. 40240–19, portion of mandible with complete dentition except broken incisor, and an associated upper dentition less incisors. Paratype, B.E.G. 40240–14, portion of right ramus containing the full tooth complement.

Formation and locality. Lower Pleistocene, Fort Hancock Formation, Madden Arroyo, locality B.E.G. 40240, NW¼NW¼ Sec. 19, T. 7, Blk. 72, Hudspeth County, Texas. Pale yellow silt four

feet thick, 111.0 feet below top of caliche on east side of arroyo.

Diagnosis. A gopher about two-thirds the size of *Geomys bursarius* (Shaw). Upper incisors bisulcate; P^4 without enamel on posterior wall; lower molars lacking enamel on their anterior faces, and tooth characters in general indistinguishable from *G. bursarius*. Mental foramen below the anterior margin of the masseteric crest, which distinguishes *G. paenebursarius* from living forms. Fossa for insertion of temporal muscle well developed, but not as deep as in *G. bursarius*. Molars are ever-growing.

Description of type specimen. The holotype (Pl. X, Fig. 7) is a left ramus of a mature adult. The proximal portion of the jaw is missing. The tooth complement is complete except for the distal portion of the incisor. The fossa for insertion of the temporal muscle is well developed, but is a little wider and not as deep as in *G. bursarius*. The masseteric ridge is prominent, positioned about midway on the jaw where it terminates almost directly below the anterior margin of P_4. The mental foramen is situated immediately below the anterior termination of the masseteric crest. Length of the occlusal surface of the tooth row is six millimeters. Paratype 40240–14 (Pl. X, Fig. 5) is a portion of a right ramus containing a complete complement of teeth. That portion of the jaw posterior to the last molar is missing. The triturating surface of the teeth is six millimeters long. The other characters of the ramus are the same as the holotype. Paratype 40240–19 is a complete, associated, upper and lower cheek tooth dentition. All that is preserved of the skull is the complete cheek tooth series. The ascending rami of the mandible are crushed and distorted and the portion of the jaw anterior to the fourth premolars is missing. This specimen was chosen for a paratype because it represents a complete dentition, less the incisors, of a single individual. Except for size, the tooth series is indistinguishable from *G. bursarius*. The name of the species is derived from Latin *paene*, almost, and *bursarius*, the name of a living species of *Geomys*.

Discussion. The fossil gopher material here described belongs to the genus *Geomys* because the upper incisors are bisulcate, P^4 lacks enamel on the posterior face, and the lower molars do not have enamel on their anterior faces. The specimens of *G. paenebursarius* from locality 40240 include three associated upper and lower dentitions, three palates with incomplete tooth series, eight mandibular rami with complete tooth complements and seven fragmental rami, each of which contains some teeth. This material is unusual in that there are associated upper and lower dentitions, the occurrence of which has not frequently been recorded.

The range of variation in characters in the specimens is, with perhaps one exception, that which could be explained by age or sexual dimorphism. The exception is the rostral portion of a skull containing both right and left P^4 and M^1 (Pl. X, Fig. 3). This is a gopher somewhat smaller than the associated material. The maximum width measured across P^4 is 5.1 mm. as compared to 5.5 mm., 6.7 mm., 6.7 mm., and 6.2 mm. in four other palates. The anterior column of P^4 is narrower than the posterior one, somewhat as in *Thomomys*, and narrower than in other specimens from the same locality. Reentrant angles of the P^4 are more open than in the living species of *Geomys* and the posterior column of the tooth lacks an enamel face. The occlusal surface of the anterior column of P^4 is completely surrounded by enamel, but further wear would expose wedges of dentine on the sides of the tooth which would isolate an enamel plate on the front. M_1 is of normal size and shape. The portion of the rostrum anterior to the teeth is distorted, but appears to be shorter than that in associated skull fragments. Upper incisors are about two-thirds as large as those of the other skulls found in the same locality. I think that the smaller size and the character of P^4 have no greater value than to identify a juvenile specimen. However, when the species is better known, the size may prove to be of greater importance than is here assigned to it.

In all the palates, with the exception described above, the P^4's are much alike. The anterior lobe is almost as large as the posterior one and is compressed anteroposteriorly in contrast to P_4 in which it is much more rounded. The valleys between the lobes in P^4 are U-shaped with flaring outer edges. There is no enamel on the posterior face of the tooth. Columns of dentine on the sides of the anterior lobe of P^4 isolate an enamel plate on the front of well-worn teeth. M^1 and M^2 are elliptical in occlusal outline, have enamel on both faces, and are typical of the genus *Geomys*. M^3 is

PLATE X

Figs. 1–8, x2; Figs. 9–11, x4; Figs. 12–13, x6.

subtriangular to rounded-triangular. The anterior part of the tooth is rounded, but the posterior portion has a rather acute angle as seen in the occlusal view. In general, there is very little variation from individual to individual in the dental characters of the upper teeth. The occlusal lengths of three upper right tooth series are 6.4 mm., 6.2 mm., and 6.4 mm., respectively. The width across the palate at the anterior lobes of P^4 in four adult specimens averages 6.27 mm.

Very little variation occurs in the lower jaws.

PLATE X

Figures— Page

1–8. *Geomys paenebursarius Strain, n. sp.* 36

1. Upper and lower cheek tooth dentition, occlusal view, B.E.G. 40240–19, paratype.
2. Skull fragment with partial upper cheek tooth complement; lower molars associated with skull, B.E.G. 40240–23.
3. Skull fragment, ventral and right side views, B.E.G. 40240–4.
4. Occlusal view of upper cheek tooth dentition with dorsal view of left mandibular ramus containing a complete tooth series of the same individual, B.E.G. 40240–22.
5. Right mandibular ramus, dorsal and right side views, B.E.G. 40240–14, paratype.
6. Dorsal and right side views of right mandibular ramus showing cheek tooth series, B.E.G. 40240–11.
7. Left mandibular ramus, dorsal and left side views, B.E.G. 40240–10, type.
8. Partial upper dentition, occlusal view, B.E.G. 40240–9.

9–10. *Citellus mcgheei* Strain, n. sp. 40

9. Lower right P_4, M_2–M_3, and upper right P^3, B.E.G. 40240–24, type.
10. Occlusal view of left P^3–P^4, and right M^1–M^3, B.E.G. 40240–24, type.

11. *Citellus finlayensis Strain, n. sp.* 41
Left mandibular ramus, left side and occlusal views, B.E.G. 40240–25, type.

12–13. *Sigmodon hudspethensis* Strain, n. sp. 35

12. A, right M_1; B, right M_2; C, left M_1; D, left M^1; E, right M^2; all occlusal views, B.E.G. 40240–1, type.
13. A, right M_1; B, right M_3; C, left M_1; D, left M_3; E, right M^1; all occlusal views, B.E.G. 40240–2, paratype.

The widest difference is in the shape of the posterior lobe of P_4 which varies from an oval to a flattened ellipse. The posterior lobe of P_4 has the anterior enamel border convex posteriorly in some individuals, giving the impression that the lateral margins of the tooth have been bent forward against the isthmus between the front and back lobes.

M_1–M_3 are without enamel on their anterior faces. In most, the lingual side of M_1 and M_2 is more compressed than the labial margin. This is a character observed in *G. bursarius.* M_3 is a smaller tooth than the other lower molars, but otherwise shows no unusual features.

Comparisons. Geomys paenebursarius may be distinguished from living species of *Geomys* and from *Geomys tobinensis* Hibbard (1944) by the fact that the mental foramen in these forms is anterior to the masseteric crest and in *G. paenebursarius* it is beneath this crest. The lack of enamel on the posterior wall of P^4 in *G. paenebursarius* distinguishes it from *Nerterogeomys* and *Thomomys* which have enamel on the posterior wall. Also, the lack of enamel on the anterior wall of the lower molars in *G. paenebursarius* distinguishes it from *Thomomys* and *Plesiothomomys,* both of which have an enamel face on both sides of the lower molars.

Although the mental foramen in *G. paenebursarius* is in much the same position as in *Cratogeomys bensoni* Gidley (1922), the bisulcate character of the upper incisors in *G. paenebursarius* and the single-grooved incisors in *C. bensoni* differentiate them and place *G. paenebursarius* in the *Geomys* group. *G. paenebursarius* is very similar in general form to *Nerterogeomys* Gazin (1942) of the Curtis Ranch Fauna, particularly in the position of the mental foramen, but the presence of enamel on the posterior side of P^4 in the Curtis Ranch form distinguishes it from *G. paenebursarius.*

G. paenebursarius differs most noticeably from *G. bursarius* in the position of the mental foramen. In view of the similarities among *Nerterogeomys, G. paenebursarius,* and *G. bursarius,* it is possible that *G. paenebursarius* stands in an intermediate position between the other two. *Geomys bursarius* could have evolved from *Nerterogeomys* through the initial loss of the enamel on the posterior face of P^4 (the *G. paenebursarius* stage) followed by the forward migration of the mental foramen.

Age relation. I consider *G. paenebursarius* to be Blancan because of the association of *Plesippus* and *Nannippus.* Further, these gophers have ever-growing cheek teeth, and according to Hibbard (1954: 356) the development in the gophers of ever-growing cheek teeth from rooted teeth took place in late Pliocene time. The Fort Hancock Formation, in which *G. paenebursarius* was found, lies below the Pearlette Ash which is late Kansan. Thus the age of *G. paenebursarius* is within the range from late Pliocene to late Kansan. Because of the advanced evolutionary stage of the species and the association of *Sigmodon* and *Gopherus*, warm climate dwellers, it is most probable that the age of *G. paenebursarius* is Aftonian.

Family SCIURIDAE

Genus CITELLUS Oken, 1816

Citellus mcgheei Strain, n. sp.

Pl. X, Figs. 9, 10

Holotype. Fragment of skull containing left P^3–P^4 and right M^1–M^3 with an associated right P^3; lower right P_4 and M_2–M_3, B.E.G. 40240–24.

Formation and locality. Lower Pleistocene, Fort Hancock Formation, Madden Arroyo, locality B.E.G. 40240, NW¼NW¼ Sec. 19, T. 7, Blk. 73, Hudspeth County, Texas. Pale yellow silt four feet thick, 111.0 feet below top of caliche on east side of arroyo.

Diagnosis. A large terrestrial squirrel about three times as large as *Citellus mexicanus parvidens.* P^3 is almost one-half as large as P^4. P^4–M^2 moderately high-crowned; anterior cingulum joins protocone with abrupt change in direction; metaloph bears a distinct metaconule and is separated from the protocone by a sulcus. Mesostyle present. M^3 one-fifth larger than M^2; no metaloph in M^3, but an incipient metacone and metaconule distinguishable. Posterior cingulum on M^3 bends abruptly backward as it leaves the protocone. P_4 is subtriangular, rounded particularly in front, and three-fourths as large as M_2. Protoconid and parametaconid separated by a narrow valley bordered anteriorly by a minute protolophid. M_2 subquadrate in occlusal view.

Material. The right P^3 and lower P_4, M_2–M_3 were found in intimate association, though not articulated, with the skull fragment, and because of the close association and the similar stage of wear, the teeth are assumed to belong to the same individual.

Description. Tooth wear indicates a young adult. Although some teeth are missing from both sides of the palate, those missing on one side have their counterparts preserved on the other. P^3 is almost one-half as large as P^4, oval in occlusal view, and slightly wider transversely than anteroposteriorly. A single ridge with two incipient lateral cusps forms the crest. This ridge passes obliquely forward from the posterior labial margin. A minute shelf-like cingulum is present on the anterior labial portion of the tooth. On the posterior lingual side there is a well-developed cingulum bordering an elongate, narrow pit which in the right P^3 opens on the lingual side with a narrow V-shaped notch. P^4 is moderately high-crowned and has a triangular occlusal surface. The anterior cingulum joins the protocone with an abrupt change of direction. The anterior valley is the same length as the central one and is confined to the labial half of the tooth. The trigon is narrowly triangular. The metaloph bears a distinct metaconule, but does not join the protocone. A mesostyle is present at the outer edge of the deep V-shaped, centrally located valley.

Upper molars are wider than long. The occlusal outline of M^1 and M^2 is subtriangular with trigon narrowly V-shaped. The anterior cingulum joins the protocone with an abrupt change of direction and the anterior valley is as large as the median valley. The metaloph bears a distinct metaconule and is separated from the protocone by a sulcus. Cingula are lower than the lophs. A mesostyle is present on M^1 and M^2.

M^3 is one-fifth larger than M^2 and has an anterior cingulum as in the other molars. The posterior cingulum bends abruptly backward as it leaves the protocone. There is no metaloph, but there is an incipient metacone and metaconule with a valley between them. This trench connects the posterior valley of the tooth with the posterior basin which, in effect, is a broadly ovate shelf with a shallow depression near its center. A mesostyle is present. Occlusal surface length in M^1–M^3 is 8.7 mm.

In the lower dentition P_4 is subtriangular, rounded particularly in front, and about three-fourths as large as M_2. The protoconid and the parametaconid are separated by a narrow valley which terminates anteriorly in a small deep pit

bordered by a minute protolophid. A prominent ectolophid bearing an incipient metaconid connects the protoconid and the hypoconid. The hypoconid is deflected forward causing the hypoflexid to have a rather narrow, deep posterior margin. The hypoflexid is open at the top, but the borders converge downward to terminate in a narrow trough. A weakly developed entoconid passes into the posterior cingulum which connects it with the hypoconid. Just anterior to the entoconid there is a slight notch in the enamel ridge connecting the entoconid and parametaconid. There is a distinct pit in the posterior labial corner of the well-developed basin of the tooth.

M_2 is subquadrate, wider than long, and has a hypoflexid as in P_4. The ectolophid and central basin of M_2 are developed as in P_4. The entoconid is prominent and has a notch in the enamel on the anterior side.

M_3 is subtriangular, rounded on the posterior margin, and about one-fourth longer than wide. The basin of the tooth is a distinct depression and adjacent to the ectolophid it has a deep trough which is expanded on both ends. The entoconid is prominent and has a conspicuous notch on its anterior side. The hypoconid is deflected forward into the hypoflexid, forming a narrow trough along the posterior margin of the hypoflexid. On all lower teeth the parametaconid is equally or slightly better developed than the other conids.

This specimen is named in honor of Mr. and Mrs. Percy Wear McGhee of El Paso, Texas.

Citellus mcgheei
Measurements of Upper Teeth

	Width	Length (with anterior angulum)
LP^4	3.00 mm.	2.50 mm.
RM^1	3.30 mm.	2.40 mm.
RM^2	3.70 mm.	2.40 mm.
RM^3	3.70 mm.	3.20 mm.

Discussion. No attempt has been made to place this specimen in a subgenus, but it is my opinion that it is probably closely related to the subgenus *Ictidomys.*

Citellus mcgheei is one-fourth larger than *C. rexroadensis* Hibbard (1941a) and *C. dotti* Hibbard (1954). *C. mcgheei* is approximately twice as large as *C. meadensis* Hibbard (1941b) and *C. howelli* Hibbard (1941a). *C. cragini* Hibbard (1941b) and *C. bensoni* Gidley (1922) both have cuspules in the posterior basin area of M^3, but *C. mcgheei* does not display this feature. *C. cochisei* Gidley (1922) cannot be confused with *C. mcgheei* because in *C. cochisei* the metaloph is attached to the protocone and in *C. mcgheei* it is not. *C. mcgheei* differs from *C. finlayensis* Strain, n. sp., because in *C. mcgheei* there is a protolophid on P_4, the hypoconid is more acutely deflected into the hypoflexid, and there is a swelling in the ectolophid.

Citellus finlayensis Strain, n. sp.
Pl. X, Fig. 11

Holotype. Portion of a left mandibular ramus containing a complete cheek tooth complement, B.E.G. 40240–25.

Formation and locality. Lower Pleistocene, Fort Hancock Formation, Madden Arroyo, locality B.E.G. 40240, NW¼NW¼ Sec. 19, T. 7, Blk. 73, Hudspeth County, Texas. Pale yellow silt four feet thick, 111.0 feet below top of caliche on east side of arroyo.

Diagnosis. A large ground squirrel about one-fourth larger than *C. rexroadensis* Hibbard (1941a). P_4 subtriangular, four-fifths as large as M_1, with a narrow hypoflexid which is inclined forward at an angle of about 45 degrees to the anteroposterior axis of the tooth row. Protolophid absent. Protoconid and parametaconid separated by a narrow V-shaped valley. M_1 quadrate, M_2 slightly rhombohedral and narrowed posteriorly. Hypoflexids narrow.

Description. Dental wear indicates an adult. The ascending ramus and the symphyseal region of the jaw are missing. The masseteric fossa extends forward to the plane of the posterior border of P_4 and the ventral margin of the fossa is more prominent than the dorsal margin. In P_4 the parametaconid and the hypoconid bend into the hypoflexid in a manner which slightly closes the flexid and causes its lingual margin to be broader than the labial margin. In all the molars the hypoconid is deflected forward and in M_3 the posterior border of the hypoflexid is constricted by the forward deflection of the hypoconid. All cheek teeth have well-developed basins whose deepest portion is a pit adjacent to the hypoconid-ectolophid juncture. The entoconid is joined to the parametaconid by a narrow ridge which in M_1–

M_3 has a distinct crenulated inward flexure midway between the two conids. The ectolophid is well developed, but bears no evidence of a mesoconid. On all teeth the parametaconid is the highest cusp. Length of P_4–M_3 is 10.5 mm.

This specimen is named for the Finlay Mountains which lie five miles to the north of locality B.E.G. 40240.

Discussion. This specimen might conceivably be placed in the subgenus *Otospermophilus*, but additional material is needed before such an assignment can be made with confidence. *C. finlayensis* can be distinguished from *C. tridecemlineatus* (Mitchill), *C. spilosoma* (Bennett), and *C. meadensis* Hibbard (1941b) because it is about twice as large. It is one-third larger than *C. howelli* Hibbard (1941a). *C. finlayensis* is about the same size as *C. rexroadensis* Hibbard (1941a), but P_4 in *C. finlayensis* is subtriangular and has a valley between the protoconid and parametaconid whereas in *C. rexroadensis* the tooth is quadrate and lacks this valley. In P_4 particularly, the hypoflexid is narrower and extends farther down the tooth in *C. finlayensis* than in *C. rexroadensis*. This results in a clearer definition of the protoconid and hypoconid in *C. finlayensis* than in *C. rexroadensis*. *C. finlayensis* is about the same size as *C. dotti* Hibbard (1954). However, in *C. finlayensis* P_4 is slightly larger and more triangular, there is no mesostylid at the base of the parametaconid, nor is there an enamel pit between the protoconid and parametaconid as in *C. dotti*.

Order PERISSODACTYLA
Family EQUIDAE
Equus (*Plesippus*) *idahoensis* (Merriam)
Pl. XI

Material. A portion of the mandible containing a complete tooth complement with the exception of the right canine, B.E.G. 40241–5.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Campo Grande Arroyo, locality B.E.G. 40241, NE¼NW¼ Sec. 3, T. 7, Blk. 73, Hudspeth County, Texas. Bones occur approximately 50 feet below top of caliche.

Description. The large canine tooth, the size of the jaw, and the wear on the teeth indicate that this specimen is a young adult male of a large species (Table 2). The incisor teeth have a distinct infundibulum. In I_1 and I_2 the cup is toward the lingual side. On the lingual border of I_3 the infundibulum forms a sharp "V," with the apex downward. This gives the tooth a scoop shape, and causes it to flare and to become shallower toward the grinding surface.

The left canine is preserved and shows almost no wear. It is stout and bears a prominent narrow crest passing over the tooth anteroposteriorly. About half way up the tooth the crest displays a distinct, inwardly bent flare.

The cheek teeth are large, robust, and heavily cemented. P_2 shows no unusual characters. P_3 is the largest of the series although it is only slightly larger than P_4. The floor of the entoflexid in all the premolars is rather elaborately folded, which may be attributed to the early stage of wear. The premolars are distinctly larger than the molars. In M_1 the reentrant valley between the protoconid and the hypoconid does not pass through the isthmus between the flexids as is commonly seen in plesippine teeth. The M_2 of the left side shows a more normal plesippine condition in which the external reentrant valley passes between the flexids to abut against the trough between the metaconid and metastylid. The right M_2 displays a condition similar to the first molar. It is quite logical to suppose that if the two second molars were found isolated from the others, they might be considered as representative of different species, if not different genera. The third molars are typical of *Plesippus* in that the external valley enters the isthmus between the flexids and meets the reentrant valley between the metaconid and the metastylid.

Discussion. The rather atypical condition of the enamel folds of the molars might be ascribed to the relatively early stage of wear, or to progressive evolutionary changes in plesippine dentition in which the external gutter did not pass between the flexids. It is interesting to observe that the enamel pattern in the first molars and the right second molar is similar to that in the genus *Asinus*. If these three teeth were found isolated from the others, one might logically assign them to that genus.

The parastylid is simple and in P_2 has a distinct plication in the posterior wall. A flexure is also present in the posterior wall of the parastylid in P_3–M_3. In P_3 it is quite prominent, but becomes

less distinct progressively through the series until in M_3 the posterior wall shows only a slight irregularity. The lingual extremity of the parastylid is about even with the middle of the metaconid in P_4–M_3, but in P_3 it is slightly shorter.

The hypoconulid is well developed in all teeth, and except for M_3, it is larger in the premolars than in the molars. The anteroposterior diameter of the hypoconulid is shorter in the premolars than in the molars.

Specimen 40241–5 is too large to be classified as *Equus* (*Plesippus*) *simplicidens* (Cope), but it is within the size range of *P. shoshonensis* Gidley (1930), *P. idahoensis* (Merriam) 1918, *P. francescana* (Frick) 1921, and *Equus* (*Plesippus*) *crenidens* Cope (1884). It differs, however, in some particular from each of these. P_2 is longer in 40241–5 than in *P. francescana* and the anteroposterior diameter of the grinding surface of the cheek tooth series is longer in 40241–5. Schultz (1936) directed attention to the fact that in the molars, the apex of the gutter between the metaconid and the metastylid was flat. This feature is seen in the second and third molars in 40241–5. Obviously this character is variable, even within an individual, and is probably of questionable specific value. Although the differences between these two specimens are small they are here considered to be definitive.

P. shoshonensis has a shorter P_2–M_3 anteroposterior grinding surface dimension and the entoconulid is not as well developed as in 40241–5. These characteristics serve to differentiate the species.

Plesippus idahoensis and the specimen here described are regarded as conspecific. A comparison was made with a lower right cheek tooth

TABLE 2

Tooth Measurements of *Plesippus idahoensis*
B.E.G. 40241–5

Tooth	Anteroposterior Diameter in mm.	Transverse Diameter in mm.
P_2	40.4	16.4
P_3	33.3	17.8
P_4	32.7	17.3
M_1	29.3	15.7
M_2	30.7	14.0
M_3	32.7	13.3
I_1		15.0
I_2		18.1
I_3		20.2
Canine	14.7	

Diastema between I_3 and P_2, left side, 123 mm.

series of *P. idahoensis*, University of Michigan Museum of Paleontology No. 33777, from Jackass Butte, Idaho. The specimens were found to be essentially identical. There are some differences in the configuration of the enamel in the molars, but these are not believed to be of specific value because there is as much variation between the two molar series of 40241–5 as there is between the specimens which were compared.

Plesippus proversus (Merriam) 1916 differs from the *P. idahoensis* specimen under discussion because according to Merriam (1916: 528), *P. proversus* molars have metaconid-metastylid column commonly wide anteroposteriorly and narrow transversely with inner groove broad and flat as in some variations of *Equus*. In some the inner groove of the metaconid-metastylid column is sharper than in *Equus* and more nearly resembles that in *Pliohippus*. A comparison of Pl. XI with Merriam's figures shows clearly that *P. idahoensis* molars have a deeper and more acute angle between the metaconid and the metastylid.

The type specimen of *E.* (*P.*) *crenidens* Cope consists of P^2 and P^3 and cannot be directly compared to 40241–5.

Equus (*Plesippus*) *simplicidens* (Cope)
Pl. IX, Figs. 5, 8, 9; Pl. XII, Fig. 11
Equus simplicidens Cope, 1892.
Plesippus simplicidens (Cope) Matthew, 1924.

Material. Fragmentary left lower cheek tooth dentition, B.E.G. 40244–4. RM^1 or RM^2, B.E.G. 40244–5; RP^4 B.E.G. 40550–1; and a broken LP^4, B.E.G. 40253–1.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Arroyo Diablo, locality B.E.G. 40244, NW¼SE¼ Sec. 2, T. 7, Blk. 74, Hudspeth County, Texas. Gray sand immediately above bedded clay and silt on east side of arroyo. Locality B.E.G. 40253, SW¼NW¼ Sec. 12, T. 7, Blk. 74, Hudspeth County, Texas. Gray sand immediately above reddish-brown bedded silt and clay, 30 feet below top of caliche, east side of Arroyo Diablo. Locality B.E.G. 40550, NE¼SW¼ Sec. 32, T. 7, Blk. 74, Hudspeth County, Texas. Brown silty clay 50 feet below escarpment.

Description. The lower cheek tooth series 40244–4 is broken, but is well enough preserved to be identified. The roots of M_2–M_3 are broken, but the grinding surfaces retain all details per-

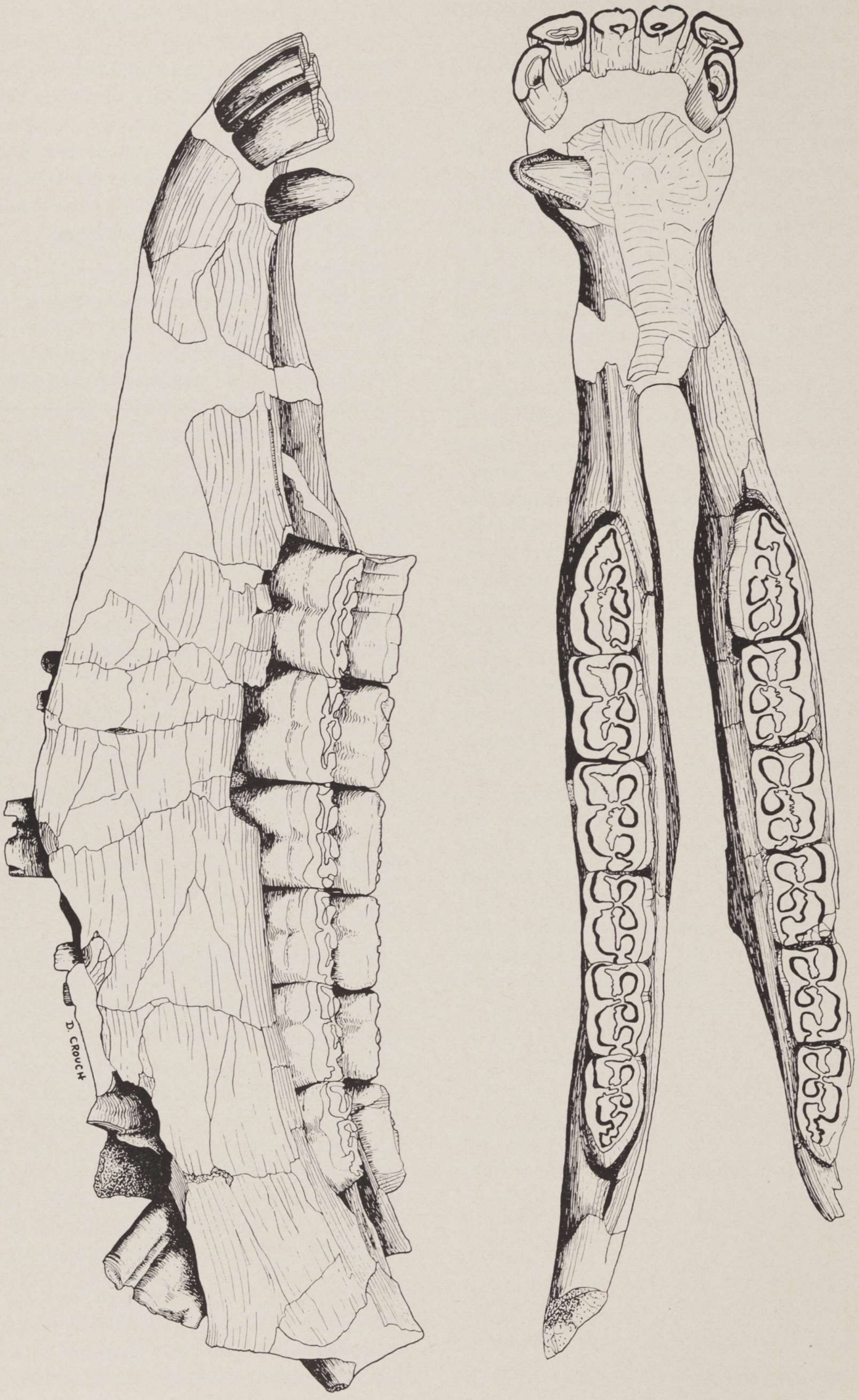

PLATE XI

Equus (Plesippus) idahoensis (Merriam)

Mandible, occlusal and left side views, B.E.G. 40241–5. One-half natural size.

p. 42

fectly. The metaconid and metastylid in all teeth are rounded and separated by a V-shaped groove. In the molars the external valley passes between the flexids and almost meets the apex of the V-shaped fold between the metaconid and metastylid.

The lingual extremity of the paralophid is about even with the center line of the metaconid and the lophid has a distinct backward flexure in its posterior wall. The entoconulid is preserved in P_3, M_2, and M_3. The dental wear indicates an individual in early old age. M^3 has an anteroposterior length of 33 mm. and a width of 13.8 mm.

Of the isolated teeth only 40550–1, an upper right molar, is complete. It has an anteroposterior diameter of 28.7 mm., a width of 28.8 mm., and a crown height of 72.0 mm. The upper left molar, 40253–1, has almost the same measurements. The upper right molar, 40244–5, has essentially the same anteroposterior diameter as the other two, but is so broken that a transverse measurement is not possible. This last tooth represents a very old individual and is so badly worn that the hypoconal groove has disappeared.

Discussion. The character of the metaconid and the metastylid, the V-shaped valley between them, and the insertion of the external valley between the flexids place specimen 40244–4 in the subgenus *Plesippus.* Because of the size of the teeth and the simple folding of the enamel, I concluded that this specimen represents the species *simplicidens.*

In the three upper teeth referred to this species, the protocone of each is typical of the plesippines. The tooth measurements and enamel configuration also conform to the established characteristics of *P. simplicidens.*

Equus (*Asinus*) cf. *cumminsii* (Cope)
Pl. IX, Fig. 1, Table 3

Equus cumminsii Cope, 1893.

Equus (*Plesippus*) cf. *cumminsii* Hibbard, 1944.

Material. Portion of left mandibular ramus containing P_2–M_2, B.E.G. 40246–1.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Madden Arroyo, locality B.E.G. 40246, SW¼NW¼ Sec. 18, T. 7, Blk. 73, Hudspeth County, Texas. Gray sand immediately above bedded silt and clay and 60 feet below top of caliche, east side of arroyo.

Description. The ramus is broken just anterior to the mental foramen and also at the proximal end. The angle, the ascending ramus, and the last molar are missing. The jaw, which is relatively deep for its length, measures 92 mm. in depth at the posterior border of P_4. The diastema was probably rather short because the mental foramen is quite near P_2. The internal median valley between the metaconid and metastylid is V-shaped and deep. The central walls of the flexids are quite close and in the molars are so close that the external reentrant valley cannot pass between them. There is a distinct pli caballinid fold in the posterior wall of the external reentrant valley. The floor of the entoflexid is crenulated, which may be ascribed to the early stage of wear of the teeth. All teeth are quite hypsodont. The crown height of M_1 is 81.0 mm. and that of M_2 is 79.0 mm. In the premolars the anteroposterior diameter of the hypoconulid is shorter than in the molars. In all the teeth, and particularly in the premolars, there is a distinct inward bend in the labial wall of the protoconid and the hypoconid. The metastylid is "pig-ear" shaped, particularly in the premolars. The metaconid, except in P_2, is initially directed lingually and forward, then its anterior portion is deflected labially, which creates a distinct bend in the conid. This bending produces a flexure in the labial wall of the metaconid which becomes progressively less pronounced in passing from M_1 to M_3.

Discussion. The enamel pattern of the teeth is almost identical to that of 40244–4, *Plesippus simplicidens,* except that in *Plesippus* the external enamel fold passes between the flexids and in 40246–1 it does not. The configuration of the enamel in the metaconid and metastylid is almost identical in the two specimens, particularly in the premolars.

These two specimens are so much alike it becomes a subjective matter whether to consider 40246–1 an aberrant plesippine or an entirely different subgenus. The writer has chosen to place specimen 40246–1 in the subgenus *Asinus.* It is placed in this subgenus because the external enamel fold in the molars does not pass through the narrow isthmus between the flexids, which is a character of *Asinus,* and because the teeth are

PLATE XII
All figures one-half natural size.

TABLE 3
Tooth Measurements of *Equus (Asinus) cumminsii (Cope)*
B.E.G. 40246–1

Tooth	Anteroposterior Diam in mm.	Transverse Diameter in mm.	Height of Crown, mm.
P_2	31.8	15.0	
P_3	28.0	15.5	
P_4	27.0	14.8	
M_1	25.4	13.8	81.0
M_2	25.0	12.5	79.0

a little smaller and more hypsodont than in *P. simplicidens.* Although it is larger, it also quite closely resembles *Asinus francisi* (Hay). *A. cumminsii* is strikingly similar to *A. somaliensis* Frisch as figured by Quinn (1957, pl. 11, fig. 2). *Asinus pons* Quinn (1958: 603) cannot be directly compared to 40246–1 because *A. pons* was described from deciduous teeth and 40246–1 consists of permanent molars. Nevertheless, there remains a possibility that these species are identical and, if so, *A. cumminsii* has priority. *A. cumminsii* may have been derived from *Asinus mexicanus* (Lance) as was *Plesippus* according to Lance (1950), or from a closely related species of *Pliohippus.* The enamel pattern of the lower cheek teeth is quite similar in *A. mexicanus* and *A. cumminsii,* and markedly so in the premolars. An alternate view might be that *A. cumminsii* arose as an aberrant plesippine in early Pleistocene.

Nannippus phlegon (Hay)
Pl. IX, Figs. 6, 7

Equus phlegon (Hay), 1899.

Material. A complete lower right third molar, B.E.G. 40245–1, and a fragment of another M_3, B.E.G. 40250–9.

Formation and locality. Lower Pleistocene, Camp Rice Formation, locality B.E.G. 40245, NE¼ NE¼ Sec. 19, T. 7, Blk. 73, Hudspeth County, Texas. Gray sand immediately above bedded silt and clay, 60 feet below top of caliche, east side of arroyo. Locality B.E.G. 40250, NW¼NE¼ Sec. 3, T. 7, Blk. 74, Hudspeth County, Texas. Gray sand immediately above reddish-brown bedded silt and clay, 50 feet below top of caliche, east side of Campo Grande Arroyo.

Description. The complete tooth, 40245–1, is very little worn, has moderate coat of cement, and is slightly curved backward. The anteroposterior diameter is 16.1 mm., its width is 8.0 mm., and the height of the tooth is 49.7 mm. Because of the broken condition of the other specimen, 40250–9, only two measurements can be made: anteroposterior diameter, 18.0 mm., height of crown, 53.0 mm.

Discussion. These teeth have been assigned to *N. phlegon* because they have the characteristic enamel pattern and appropriate size range for the genus and species.

Equus sp.
Pl. XII, Figs. 2, 4, 5, 6

Material. The distal end of a right metacarpal, B.E.G. 40247–7; a right first phalanx, B.E.G. 40250–3; a right second phalanx, B.E.G. 40250–6; and a right second phalanx, B.E.G. 40247–8.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Campo Grande Arroyo, locality 40247, SW¼SE¼ Sec. 46, T. 6, Blk. 74, Hudspeth County, Texas. Gray sand immediately above reddish-brown bedded silt and clay, 50 feet below top of caliche, east side of arroyo. Locality 40250, NW¼NE¼ Sec. 3, T. 7, Blk. 74, Hudspeth County, Texas. Gray sand immediately above

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PLATE XII

Figures— Page

1. *Gigantocamelus* sp. 50
   Distal portion of metacarpal or metatarsal, front view, B.E.G. 40247–2.
2. *Equus* sp. 47
   Distal portion of right metacarpal, front view, B.E.G. 40247–7.
3. *?Tanupolama* 50
   Calcaneum, front and right side views, B.E.G. 40241–8.

4–6. *Equus* sp. 47
   4. Second phalanx, front view, B.E.G. 40247–8.
   5. Second phalanx, front view, B.E.G. 40240–6.
   6. First phalanx, front view, B.E.G. 40250–3.

7. *Tanupolama* sp. 50
   Distal portion of metapodial, front view, B.E.G. 40248–2.

8–10. *Odocoileus* sp. 50
   8. First phalanx, front and side views, B.E.G. 40241–9.
   9. Proximal portion of antler, B.E.G. 40255–1.
   10. Proximal portion of antler, B.E.G. 40551–2.

11. *Equus (Plesippus) simplicidens* (Cope) 43
   Portion of left mandibular ramus, occlusal view, B.E.G. 40244–4.

reddish-brown bedded silt and clay, 50 feet below top of caliche, east side of Campo Grande Arroyo.

Discussion. The various specimens were compared with homologous bones of *Asinus domesticus.* The distal portion of the metacarpal, 40247–7, is one-fifth larger and the shaft of the bone is relatively more robust than in the modern form. This comparison indicates that the fossil species must have been larger than the domestic ass.

The second phalanx, 40247–8, is about two-thirds as large as that of the *Asinus domesticus* with which it was compared. The first and second phalanges, 40250–3 and 40250–6, respectively, are from individuals which were about twelve percent smaller than the living form.

Family TAPIROIDEA
Tapirus cf. *copei* Simpson
Pl. XIII

Tapirus haysii Cope, 1899.

Material. Part of a palate containing a broken cheek tooth series, B.E.G. 40241–1.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Campo Grande Arroyo, locality B.E.G. 40241, NE¼NW¼ Sec. 3, T. 7, Blk. 73, Hudspeth County, Texas. Bones occur approximately 71 feet below top of caliche.

Description. The specimen represents an old individual and, except in RM^2 and RM^3, the teeth are worn so badly that the details of the crown are obliterated. Weathering has damaged the left side of the palate and that part of the maxillary which contains P^4–M^1 is missing. The other teeth of the left side are so badly broken that no reliable measurements can be made.

Although worn and broken, the right tooth series is well enough preserved to be measured. Enamel thickness must be estimated in at least one dimension in most teeth, but the measurements are believed to be no more than five percent in error (Tables 4, 5). P^4 is triangular in occlusal outline, with all sides about equal in length.

TABLE 5

Comparative Upper Cheek Tooth Indices of *Tapirus* cf. *copei, B.E.G.* 40241–1, and *Tapirus copei* Simpson (1945)

	Tooth	*T.* cf.*copei,* B.E.G. 40241–1	*T. copei* Simpson (1945) range
	P^1	85	79–96
	P^2	116	114–126
	P^3	138	113–126
100Wa / L	P^4	142	113–132
	M^1	145	110–112
	M^2	123	108–125
	M^3	115	112–117
	P^1	86	
	P^2	89	92–95
	P^3	103	100–103
100Wa / Wp	P^4	108	102–106
	M^1	105	109–112
	M^2	124	105–112
	M^3	129	113–119

Wa=anterior width; L=length; Wp=posterior width.

TABLE 4

Comparative Tooth Measurements of *Tapirus* cf. *copei, B.E.G.* 40241–1, and *Tapirus copei* Simpson (1945)

Tooth	*T.* cf. *copei,* B.E.G. 40241–1			*T. copei* Simpson Range		
	L	Wa	Wp	L	Wa	Wp
P^1	21.4°	18.3°	21.2°	22.4–24.9	19.6–21.5	
P^2	21.6	25.0°	28.0°	21.9–24.0	25.5–26.5	27.4–27.9
P^3	21.5°	29.6°	28.7°	22.7–24.5	27.0–29.5	26.1–29.0
P^4	22.1°	31.4°	29.0°	24.1–26.4	29.9–31.8	28.4–30.1
M^1	21.7	31.5°	30.0°	25.8–26.4	28.9–31.1	25.8–27.9
M^2	27.8	34.3°	27.6°	27.3–29.7	31.3–34.9	28.0–31.5
M^3	29.0	33.3	25.8°	26.8–29.2	31.0–34.1	26.5–29.0

All measurements given in millimeters. Wa = anterior width; L = length; Wp = posterior width.
°Estimated, but error believed to be no more than the width of the enamel.

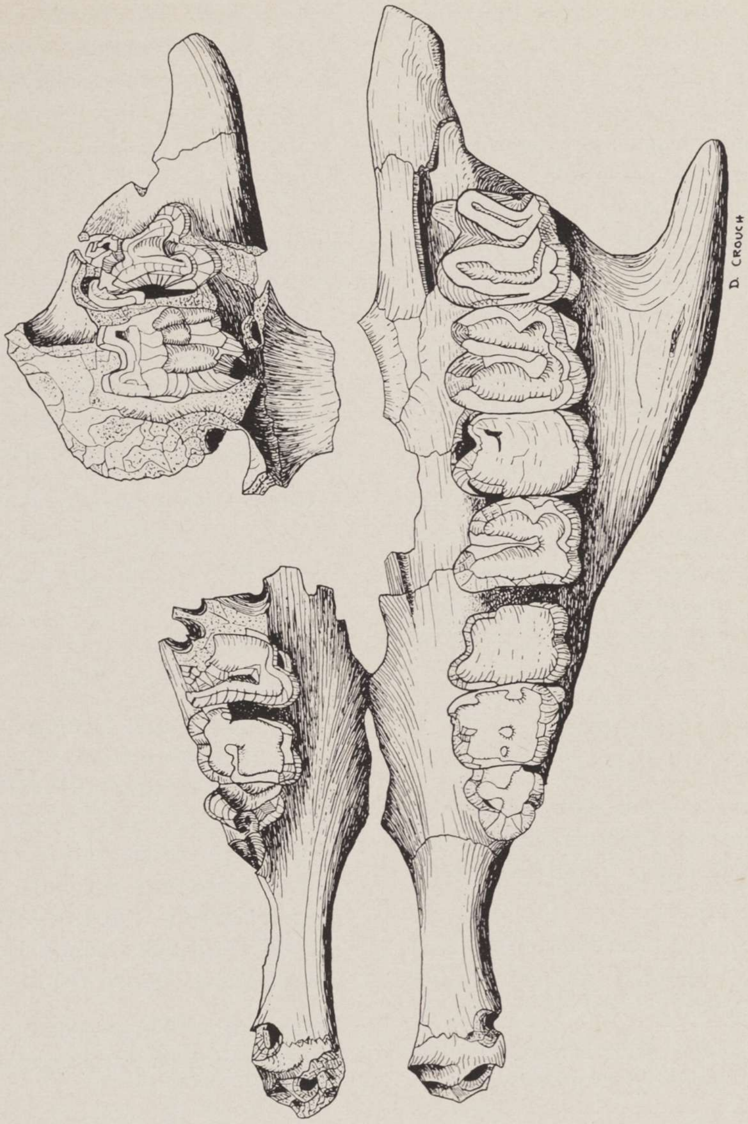

PLATE XIII
***Tapirus* cf. *copei* Simpson**
Palate, B.E.G. 40241–1.
One-half natural size.
p. 48

Its shape is quite similar to that of the P^4 of *T. copei* figured by Simpson (1945: 67). P^2–P^4 are molariform, but no details of the crown are preserved. M^1 is so worn that only its anteroposterior diameter can be determined. The ectoloph of M^2 has a valley at the point where the protoloph joins it and there is another valley just anterior to the metacone. On the posterior lingual side of the metacone there is a valley forming a notch in the posterior wall of the metaloph. M^3 has an ectoloph with about the same characters as that of M^2. The metaloph diverges from the protoloph to form almost a right angle in the apex of the posterior valley. There is a small well-developed cingulum on the anterior labial border and a prominent short one on the posterior lingual margin of the tooth.

The symphyseal region is missing as well as the incisor and canine teeth. The diastema is 44.5 mm. measured between the alveolus of P^1 and that of the canine tooth.

Discussion. This specimen is larger than most other tapirs described from the Pleistocene. Its size alone distinguishes it from all but *T. copei*. *T. merriami* Frick (1921) may approach it in size, but Frick established that species on lower molars only, so the two cannot be accurately compared. Simpson (1945) established *T. copei* as a new name for *T. haysii* Cope (1899), but not *T. haysii* Leidy (1860). Simpson stated (1945: 66):

> The fact is that this type is essentially indeterminate and that the species to which it belongs, and consequently the species properly called *T. haysii*, cannot at present be identified, in spite of the extensive use of this name in the literature.

The specimen from the Camp Rice Formation is not precisely like *T. copei*, but it is nearer in size to this than to any other adequately described species from the Pleistocene. There is a possibility that the Camp Rice specimen represents a new species, but owing to its poor state of preservation it is inadvisable to cite it as a type.

Order LAGOMORPHA
Family LEPORIDAE

Material. Fragment of lower right mandibular ramus containing two deciduous premolar teeth, B.E.G. 40240–5. One upper right molariform tooth, B.E.G. 40240–6.

Formation and locality. Lower Pleistocene, Fort Hancock Formation, Madden Arroyo, locality B.E.G. 40240, NW¼NW¼ Sec. 19, T. 7, Blk. 73, Hudspeth County, Texas. Pale yellow silt four feet thick, 111.0 feet below top of caliche on east side of arroyo.

Discussion. These fragments represent the only lagomorph remains recovered. The taxonomic relationship is uncertain below the family level, but it is important to record the presence of the rabbits in the fauna. Wood *et al.* (1941: 13) listed *Hypolagus* as a characteristic fossil of the Blancan fauna and the scarcity of rabbit bone in the Hudspeth local fauna is surprising.

Order ARTIODACTYLA
Family CAMELIDAE
Genus *Tanupolama* Stock, 1928
Tanupolama sp.
Pl. XII, Figs. 3, 7

Material. Distal portion of metapodial, B.E.G. 40248–2, and a calcaneum, B.E.G. 40241–8.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Campo Grande Arroyo, locality B.E.G. 40241, NE¼NW¼ Sec. 3, T. 7, Blk. 73, Hudspeth County, Texas. Bones occur 60 feet below top of caliche. Locality B.E.G. 40248, SE¼NW¼ Sec. 12, T. 7, Blk. 74, Hudspeth County, Texas. Gray sand immediately above reddish-brown bedded silt and clay, 60 feet below top of caliche, east side of Diablo Arroyo.

Discussion. The metapodial is too fragmentary to present information other than to establish the presence of the genus in the fauna. The calcaneum is tentatively referred to this genus. It is from the right limb and is 113 mm. long.

Genus *Gigantocamelus* Barbour and Schultz
Gigantocamelus sp.
Pl. XII, Fig. 1

Material. Distal portion of metacarpals or metatarsals, B.E.G. 40247–2 and 40551–1.

Formation and locality. Lower Pleistocene, Camp Rice Formation, Campo Grande Arroyo, locality B.E.G. 40247, SW¼SE¼ Sec. 46, T. 6, Blk. 74, Hudspeth County, Texas. Gray sand immediately above reddish-brown bedded silt and clay, 50 feet below top of caliche, east side of arroyo. Locality B.E.G. 40551, SW¼NW¼ Sec. 16, T. 6, Blk. 75, Hudspeth County, Texas. Gray sand, east side of Alamo Arroyo, ten feet above stream level.

Discussion. These specimens demonstrate the presence of *Gigantocamelus* in the fauna.

Family CERVIDAE
Genus *Odocoileus* Rafinesque
Odocoileus sp.
Pl. VII, Figs. 8, 9, 10

Material. A first phalanx from the right side of the foot, B.E.G. 40241–9 and the proximal end of two antlers, B.E.G. 40255–1 and 40551–2.

Formation and locality. Lower Pleistocene, Camp Rice Formation, locality B.E.G. 40241, NE¼NE¼ Sec. 3, T. 7, Blk. 73, Hudspeth County, Texas. Bones occur 28 feet below top of caliche, Campo Grande Arroyo. Locality B.E.G. 40255, SE¼SE¼ Sec. 33, T. 7, Blk. 73, Hudspeth County, Texas. Gray sand immediately above reddish-brown bedded silt and clay, 60 feet below escarpment on west side of arroyo. Locality B.E.G.

40551, SW¼NW¼ Sec. 16, T. 6, Blk. 75, Hudspeth County, Texas. Gray sand, east side of Alamo Arroyo, ten feet above stream level.

Discussion. Two species are probably represented. The antler fragments are from a large species of deer, but the first phalanx represents a much smaller one. The phalanx is 48 mm. long, the transverse measurement of the proximal end is 16.8 mm. and the anteroposterior diameter is 20 mm.

Both antler fragments are about the same size and length. 40255–1 is 100 mm. long and has a maximum diameter of 49 mm. at the base. 40551–2 is a little less robust and has a diameter of 44 mm. at the proximal end.

MEASURED SECTIONS

Section 1, Camp Rice Formation. Finlay railroad cut, one-half mile from west end. SE¼ SE¼ Sec. 17, T. 7, Blk. 73. Section begins at level of railroad.

	Thickness (feet)
4. Medium sandstone, poorly sorted, tough; grayish orange (10YR 7/4); calcareous cement, caliche nodules; forms steep slopes	12.3
3. Sandy pebble gravel, friable, occasional boulder; grayish orange-pink (10YR 7/2)	6.4
2. Volcanic ash (Pearlette), friable; yellowish-gray (5YR 8/1)	3.0
1. Medium sand, loose to friable, cross-bedded; yellowish-gray (5YR 7/2) to pale yellowish-brown (10YR 6/2)	11.8
Total	33.5

Section 2, Camp Rice Formation. Madden Arroyo one-fourth mile south of west end of Finlay railroad cut. NW¼NE¼ Sec. 20, T. 7, Blk. 73. (Reference section.)

4. Caliche, upper part dense; very pale orange (10YR 8/2)	6.2
3. Conglomerate, tough, limestone and andesite pebbles	2.5
2. Clayey siltstone, tough, even to poorly bedded; light brown (5YR 6/4), weathers to grayish orange-pink (5YR 7/2); badlands-type topography	50.0
1. Medium sandstone, friable to loose, cross-bedded; pale yellow-brown (10YR 6/2)	30.0
Total	88.7

Section 3. Camp Rice Formation and Fort Hancock Formation (type section), east side Madden Arroyo, NW¼NW¼ Sec. 19, T. 7, Blk. 73.

	Thickness (feet)
Camp Rice Formation	
15. Caliche, indurated at top, soft and powdery at base; very pale orange (10YR 8/2)	6.2
14. Fine sandstone, friable, grayish orange-pink (5YR 7/2); horizontal; shrinkage cracks prominent	2.3
13. Silty very fine sandstone, well sorted, very friable; light brown (5YR 6/4); bedding indistinct; produces steep slopes	20.2
12. Clayey very fine sandstone, tough; moderate brown (5YR 4/4), weathers to grayish orange-pink (5YR 7/2); forms steep slopes; shrinkage cracks common	6.5
11. Medium sandstone, moderately sorted, yellowish-gray (5Y 7/2); friable, cross-bedded, caliche and sandstone pebbles in one-foot layer near base. Occasional fossil bones	11.4
10. Fine sandstone, well sorted, poorly cemented; light olive-gray (5Y 6/1) to pale yellow-brown (10YR 6/2). Clay lenses with a maximum thickness of 3 feet, varying from yellowish-gray (5Y 7/2) to pale brown (5YR 5/2)	16.7
Camp Rice total	63.3
Unconformity	
Fort Hancock Formation (type section)	
9. Claystone, tough; pale reddish-brown (10R 5/4); massively bedded; prominent shrinkage cracks on surface	10.3
8. Clayey very fine sandstone, friable; pale yellowish-brown (10YR 6/2); bedding irregular to cross-bedded, forms steep slopes or cliffs	12.1
7. Silty claystone, tough; color varies from moderate brown (5YR 4/4) to pale yellowish-brown (10YR 6/2) to moderate greenish-yellow (10Y 7/4); weathers to form typical badlands topography	18.6
6. Siltstone, tough; pale yellowish-brown (10YR 6/2); contains vertebrate fossils, particularly rodents	3.8
5. Silty claystone, tough; pale grayish-red (10R 5/2); weathers to pale red (10R 6/2); forms slopes	2.0
4. Silty claystone, tough; pale grayish-red (10R 5/2) to yellowish-gray (5Y 7/2); forms slopes	9.2
3. Silty claystone, tough; grayish-red (10R 4/2); silt lenses up to 2.5 feet thick, incipient cross-bedding; steep slopes with indurated masses of silt protruding on surface	10.3
2. Slightly clayey siltstone, friable; grayish orange-pink (5YR 7/2); forms steep slopes with irregular masses of indurated silt on exposed surfaces	4.1
1. Silty claystone, tough; pale yellowish-brown (10YR 6/4); forms slopes	6.3
Fort Hancock total	76.7
Section total	140.0

Section 4, Camp Rice Formation. One mile southwest of Madden section house on railroad. NE¼NE¼ Sec. 27, T. 7, Blk 74.

	Thickness (feet)
6. Caliche; very pale orange (10YR 8/2); forms benches	4.0
5. Limestone pebble gravel, some silt and clay; light brown (5YR 6/4)	22.7
4. Clayey siltstone, tough; light brown (5YR 6/4); forms steep slopes with incipient benches	37.0
3. Pebble gravel, pebbles mostly less than 50 mm. in diameter and chiefly andesite, rhyolite, and chert	7.3
2. Clayey very fine sandstone, friable; light brown (5YR 6/4)	5.3
1. Pebble gravel; andesite, rhyolite, and chert pebbles	7.3
Total	83.6

Unconformity

Section 5, Camp Rice Formation (type section). 5.8 miles up Campo Grande Arroyo from railroad crossing at McNary, east of arroyo. NE¼NE¼ Sec. 46, T. 6, Blk. 74.

8. Caliche, dense, but platey in upper part; very pale orange (10YR 8/2)	4.0
7. Fine sandstone, poorly sorted, friable; light brown (5YR 6/4) at base grading upward to very pale orange (10YR 8/2); calcareous cement increasing upward to caliche of unit 8; forms moderate slopes	5.0
6. Fine sandstone, moderately sorted, friable; light brown (5YR 6/4); weathers to grayish orange-pink (5YR 7/2); surface tends to develop vertical ridges	5.5
5. Medium sandstone, poorly sorted, friable; bedding indistinct; pale reddish-orange (10R 6/4) weathering to moderate orange-pink (10R 7/2); scattered caliche concretions about 1 cm. in diameter; forms steep slopes	24.6
4. Silty claystone, tough, grayish orange-pink (10R 8/2); weathered surface steep with incipient ledges	3.7
3. Clayey fine sandstone, poorly sorted, friable to loose; moderate reddish-orange (10R 6/6); forms steep slopes with poorly defined ledges	25.5
2. Medium sandstone, moderately sorted, friable to loose; pale yellow-brown (10YR 6/2); forms low-angle slopes	11.0
1. Fine sandstone, well sorted, friable, cross-bedded; yellowish-gray (5Y 7/2) weathering to mottled pale yellowish-brown (10YR 6/2); irregular ledges on weathered surface. Contains vertebrate fossils	9.0
Total	88.3

Unconformity

Section 6, Camp Rice Formation (reference section). East side of Campo Grande Arroyo, 5 miles north of McNary. NE¼NW¼ Sec. 3, T. 7, Blk. 74.

Camp Rice Formation	Thickness (feet)
17. Caliche; indurated at top and grades downward to friable clayey silt; very pale orange (10YR 8/2)	6.8
16. Clayey siltstone, moderate brown (5YR 4/4) weathering to grayish orange-pink (5YR 7/2); bedding tending to be massive	5.4
15. Medium sandstone; moderately sorted, friable; light brown (5YR 5/6) weathering to brown (5YR 4/6); one-foot thick gravel layer 3 feet below top; limestone pebbles of local origin	16.3
14. Coarse sandstone; well sorted, friable; pale yellowish-brown (10YR 6/2); 2 inch caliche layer at base	4.8
13. Fine sandstone; pale yellow-brown (10YR 6/2). Has channel fill of dark reddish-brown (10R 3/4) silt which weathers to pale-reddish brown (10R 5/4)	5.5
12. Pearlette volcanic ash; very friable; very light gray (N8)	1.5
11. Medium sandstone; well sorted, friable; pale yellow-brown (10YR 6/2)	4.3
10. Medium sandstone; moderately sorted, friable; light olive-gray (5Y 6/1); irregular bedding, indurated lenses up to 3 feet thick, caliche nodules and masses up to 1 foot thick	16.0
9. Medium to fine sandstone; moderately sorted, friable; pale yellow-brown (10YR 6/2); even to poorly cross-bedded. Contains vertebrate fossils	15.8
8. Clayey fine sandstone, friable; pale yellow-brown (10YR 6/2); some cross-bedding, but generally evenly bedded. Several bands of caliche pebbles and thin clay layers; lenses of grayish-red (10R 4/2) clay up to 4 feet thick	15.9
Camp Rice total	65.9

Unconformity

Fort Hancock Formation	
7. Clayey siltstone, tough; light brown (5YR 6/4); bedding horizontal and massive	13.2
6. Very fine sandstone, well sorted, friable; light brown (5YR 6/4); bedding even and horizontal, tending to form a cliff	8.0
5. Fine sandy clay, tough; light brown (5YR 6/4); horizontally bedded and tending to form vertical exposures	2.7
4. Fine sandstone, well sorted, friable; pale yellowish-brown (10YR 6/2); upper ten feet cross-bedded, lower part contains clay lenses up to one foot thick	18.8
3. Clayey fine sandstone, well sorted, poorly cemented; grayish-red (10R 4/2); bedding horizontal	5.8
2. Silty fine sandstone, well sorted; yellowish gray (5Y 7/2); cross-bedded	4.0

	Thickness (feet)
1. Siltstone, tough, bentonitic, moderate brown (5YR 4/4); bedding massive and horizontal	5.3
Fort Hancock total	57.8
Section total	123.7

Base of escarpment

Section 7, Camp Rice Formation and Fort Hancock Formation (reference section). Four miles north of McNary, east side of Campo Grande Arroyo. NW¼NW¼ Sec. 10, T. 7, Blk. 74.

Camp Rice Formation

11. Caliche; very pale-orange (10YR 8/2); upper 3 feet consolidated, but platey, lower part porous	6.2
10. Fine sandstone, very friable, poorly sorted; light brown (5YR 6/4); grades upward into caliche	4.0
9. Gravelly fine sandstone friable, caliche cement, pebble median 1.5 cm.; grayish orange-pink (5YR 7/2); pebbles mostly andesite and chert	10.8
8. Gravelly medium sandstone, very friable, poorly sorted; orange-pink (5YR 7/2); pebbles of andesite and chert; forms slopes	5.4
7. Very fine sandstone, very friable; yellowish gray (5YR 7/2); occasional small caliche concretions at base	3.5
Camp Rice total	29.9

Unconformity

Fort Hancock Formation (reference section)

6. Clayey siltstone, tough; light brown (5YR 6/2; lenses of grayish orange-pink (5YR 7/2) silt; forms badlands-type topography	27.0
5. Clayey siltstone, friable; grayish orange-pink (5YR 7/2); forms ledges	4.0
4. Silty claystone, tough; grayish orange-pink (5YR 7/2); occasional small silt lenses	28.2
3. Siltstone, tough; pale yellow-brown (10YR 6/2); occasional indurated lenses about 2 inches thick form slabs on weathered surface; forms ledges	6.0
2. Clayey siltstone, tough; pale yellow-brown (10YR 6/2); forms slopes	7.2
1. Clayey siltstone, tough; pale reddish-brown (10R 5/4); forms moderate slopes	10.8
Fort Hancock total	83.2
Section total	113.1

Section 8, Camp Rice Formation (reference section) and Fort Hancock Formation. Campo Grande Arroyo, 3.7 miles north of McNary. SE¼NE¼ Sec. 9, T. 7, Blk. 74.

Camp Rice Formation

	Thickness (feet)
17. Caliche, upper part tough, lower 3 feet nodular; very pale orange (10YR 8/2)	5.2
16. Medium sandstone, poorly sorted, loose to friable; light brown (5YR 6.5/3); calcareous cement; forms steep slopes and ledges	8.4
15. Fine sandstone, well sorted, loose to friable; light brown (5YR 6.5/3); bedding indistinct; usually forms steep slopes	9.7
14. Gravelly fine sandstone, poorly sorted, friable; light brown (5YR 6/4); calcareous cement. Ledge former, surface studded with gravel, pebbles up to 55 mm. in diameter. Pebbles mostly andesite and rhyolite, some limestone and chert	4.4
13. Gravelly fine sandstone with bands of pebbles, loose to friable, calcareous cement; light brown (5YR 6.5/3); forms slopes. Limestone, chert, and igneous rock pebbles, mostly andesite and rhyolite. Cobbles up to 100 mm.	12.1
12. Fine sandstone with occasional very small pebbles, loose; light brown (5YR 6.5/3); forms slopes	1.9
11. Sandy cobble gravel, friable; pinkish-gray (5YR 8/1). Pebble median 20 mm., cobbles up to 70 mm., pebbles and cobbles of limestone, chert, andesite, rhyolite, and occasionally granite; calcareous cement	1.7
10. Medium sandstone, poorly sorted, friable; light brown (5YR 6/4). Occasional pebbles and cobbles may be 120 mm. in long axis; forms "pebble-studded" slopes and irregular surfaces	13.8
9. Medium sandstone, poorly sorted, friable; light brown (5YR 5.5/5); occasional pebble up to 50 mm. in diameter	0.8
8. Sandy claystone, poorly sorted, tough; light brown (5YR 6.5/3); bentonitic, forms slopes	3.1
7. Medium sandstone, poorly sorted, friable; light brown (5YR 5/6); occasional pebbles up to 35 mm. in diameter; forms slopes	2.0
6. Gravelly coarse sand, very poorly sorted, cobbles up to 100 mm. diameter, friable to loose, pebbles of chert, vein quartz, andesite, rhyolite, and occasionally granite	9.9
Camp Rice total	73.0

Unconformity

Fort Hancock Formation

5. Silt with lenses of fine sand, tough; grayish orange-pink (5YR 7/2); some crossbedding	25.0
4. Silty claystone, tough; grayish orange-pink (5YR 7/2); bentonitic, forms steep slopes	8.9
3. Siltstone, tough, massive; yellowish-gray (5Y 7/2)	0.5
2. Very fine sandstone, tough; light brown (5YR 6/4); forms vertical exposures	3.0
1. Silty claystone, tough; pale brown (5YR 5/2); bentonitic, bedding horizontal	4.2
Fort Hancock total	41.6
Section total	114.6

	Thickness (feet)
Bed of Campo Grande Arroyo	
Section 9, Camp Rice Formation. Camp Rice Arroyo, east side, 2 miles north of Interstate Highway 10. SE¼NE¼ Sec. 32, T. 6, Blk. 75.	
4. Caliche, dense at top; very pale orange (10YR 8/2)	5.0
3. Pebble gravel, medium sand, limestone pebbles, caliche cement; light olive-gray (5Y 6/1)	5.4
2. Fine sandstone, friable, poorly sorted, caliche cement, irregular caliche masses; light brown (5YR 5/6); lenses of light brown (5YR 6/4) claystone; tendency to form steep slopes with incipient ledges	27.0
1. Fine sandstone, very friable; pale yellowish-brown (10YR 6/2); forms slopes; indurated irregular masses 8 to 10 inches in diameter on slopes	21.6
Total	59.0
Section 10, Camp Rice Formation. Camp Rice Arroyo, east side, 1 mile north of Interstate Highway 10. SW¼SE¼ Sec. 32, T. 6, Blk. 75.	
5. Fine sandstone, friable, poorly sorted caliche pebbles; grayish orange-pink (5YR 7/2); overlain by windblown sand	15.0
4. Fine sandstone, friable, very poorly sorted, numerous pebbles; grayish orange-pink (5YR 7/2); weathered surface covered with small holes 5 mm. in diameter	3.6
3. Fine sandstone, very friable, poorly sorted; grayish-orange (10YR 7/4)	6.0
2. Gravel, medium sand, limestone pebbles with 20 mm. median; light olive-gray (5Y 6/1)	6.0
1. Medium sandstone, very friable; grayish orange-pink (5YR 7/2)	18.2
Total	48.8
Section 11, Camp Rice Formation, 2 miles northeast of Fort Hancock. SW¼ Sec. 14, Publ Sch. Blk. 65½.	
7. Caliche; very pale orange (10YR 8/2)	2.0
6. Fine sandstone, very friable; grayish orange-pink (5YR 7/2)	8.0
5. Gravelly medium sandstone, very friable; light olive-gray (5Y 6/1); andesite, rhyolite, and chert pebbles	25.0
4. Fine sandstone, friable; grayish orange-pink (5YR 7/2)	6.0
3. Gravelly medium sandstone, very friable; light olive-gray (5Y 6/1); pebbles of andesite, rhyolite, chert, quartz, and occasionally granite	15.0
2. Fine to medium sandstone, very friable; grayish orange-pink (5YR 7/2)	15.0
Camp Rice total	71.0
Unconformity	
Fort Hancock	
1. Siltstone, tough; pale reddish-brown (10R 5/4); contains invertebrate fossils	4.0

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